

RipStream Riparian Rule Analysis

Analysis tool development & status

22 January 2014

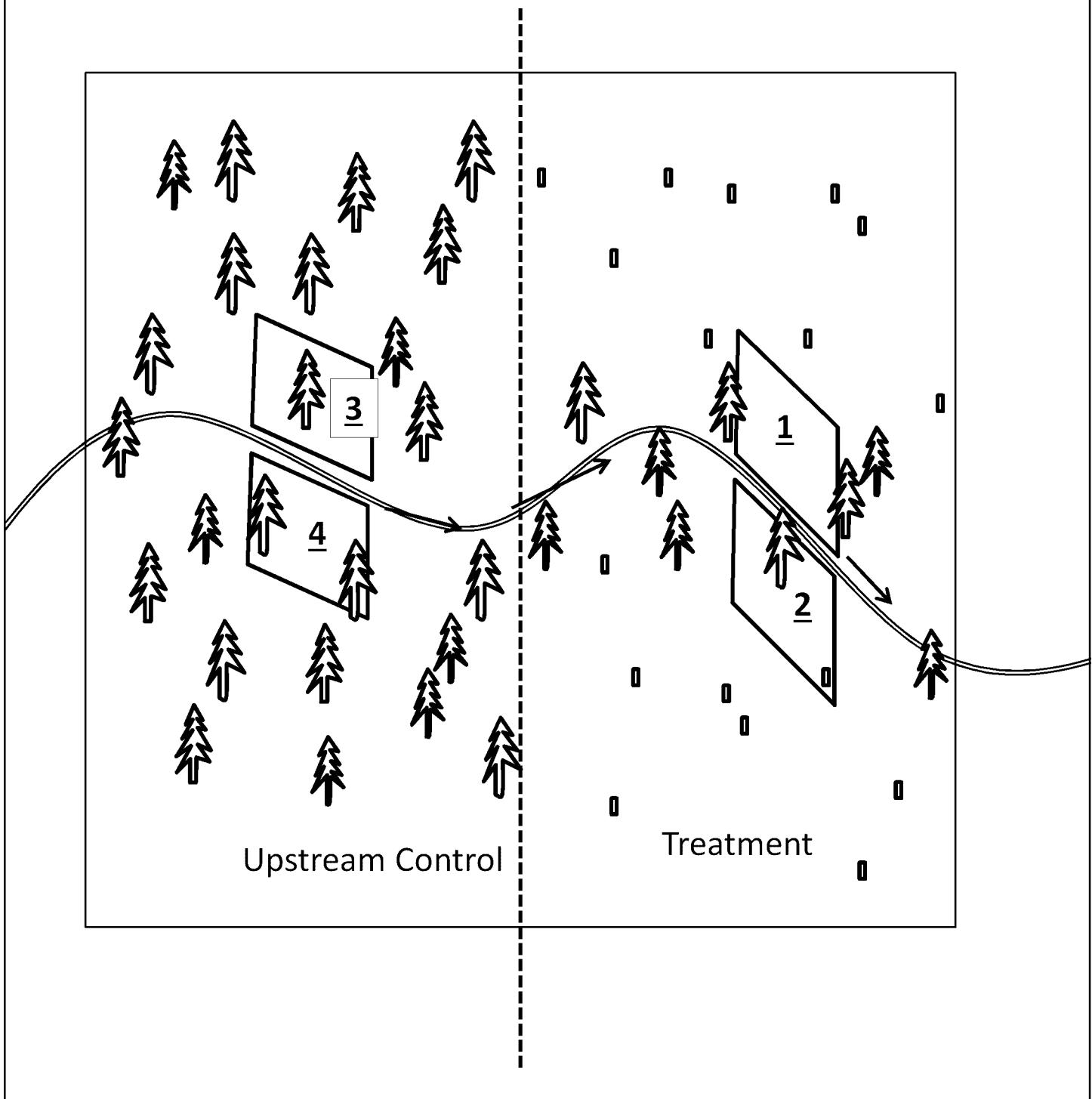
Outline

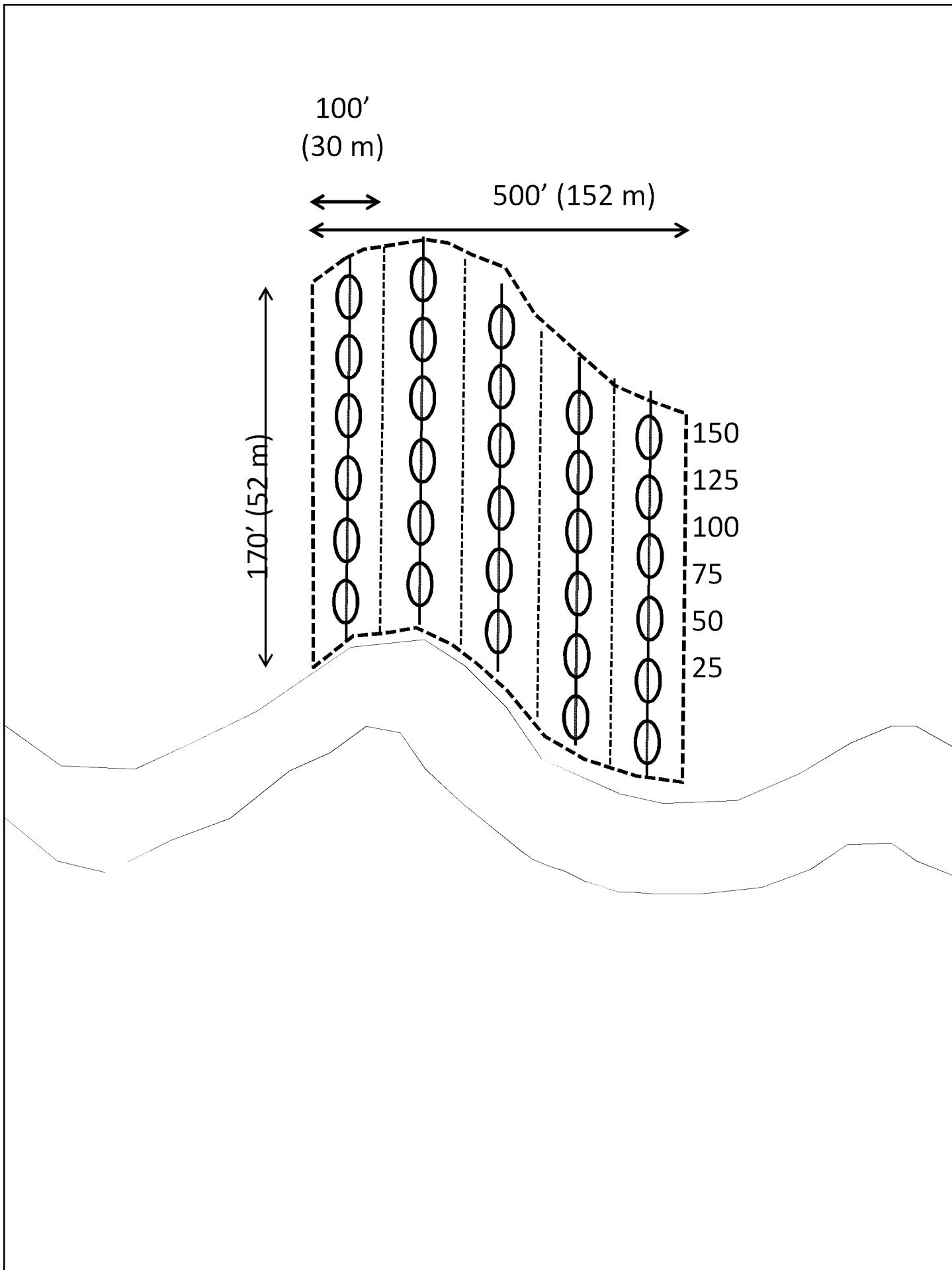
- Meeting goals
- Vegetation plots and what they tell us
- How we are using vegetation plot data
- Analysis
 - Background: what we're doing
 - How it works
 - Shade model alternatives & results
- Prediction: As harvested & State Forests
- Next Steps: FPA, alternatives

Goals

- Common understanding of model:
 - How it works
 - What goes into it
 - How it can be used
 - Role of the vegetation plot data
- Input on the model process
- Input on prescription development

PLOT LAYOUT





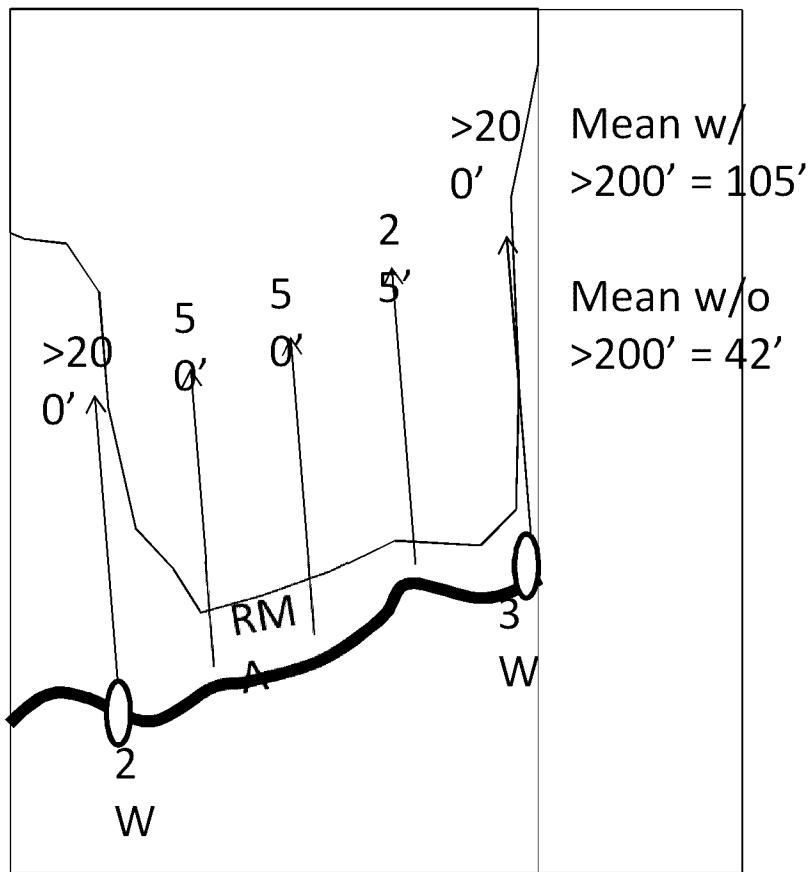
Information from veg plots

- BA pre, post, change
- Species composition
- Tree height pre (not post)
- Snag/live
- Line that trees were harvested along
- Tree distance (horizontal, slope)
- Distance from stream to “harvest”



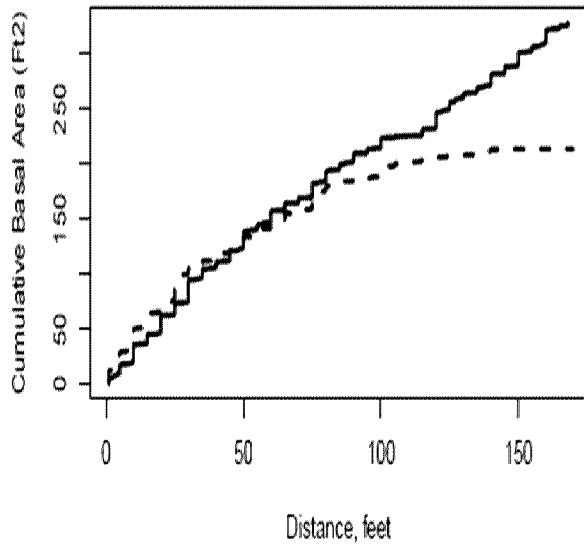
Distance

- FEM paper: used intern-measured buffer widths

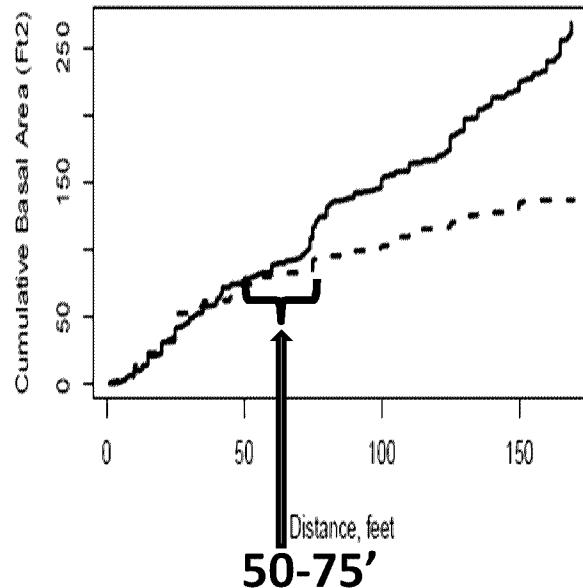


Distance – Vegetation Plots (visual)

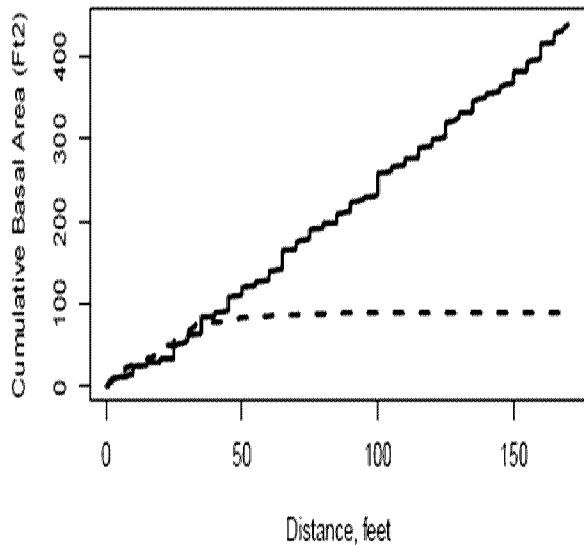
51061, Private



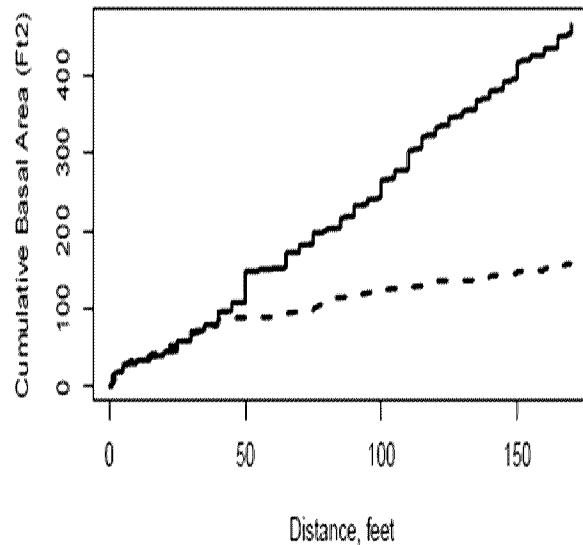
51062, Private



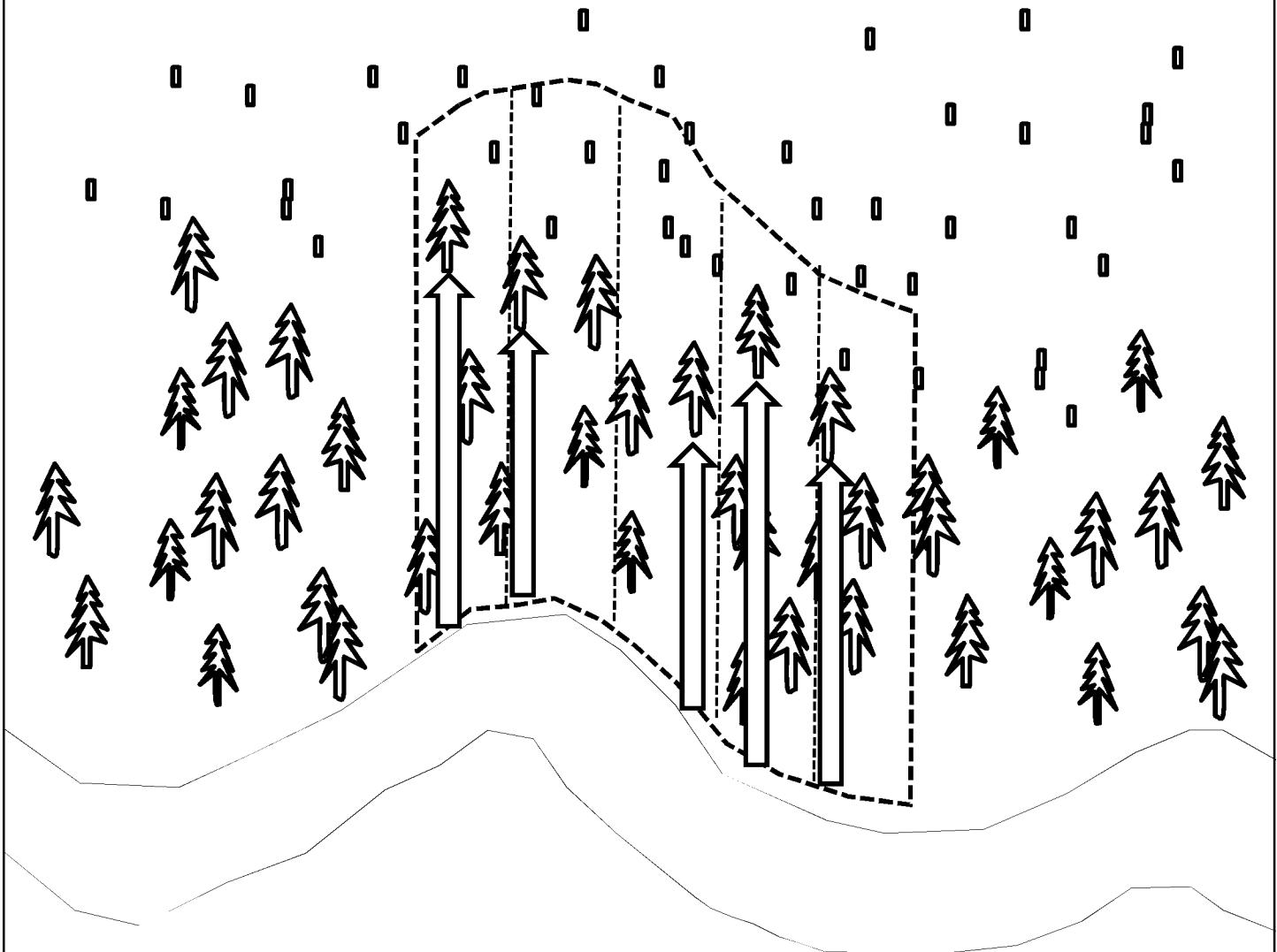
52041, Private



52042, Private



Distance: Vegetation Plot (Empirical)



DISTANCE

Which tree in
each line is the
farthest from the
stream?

Of the 5 maximum line
distances...

Minimum?

MinMaxDist

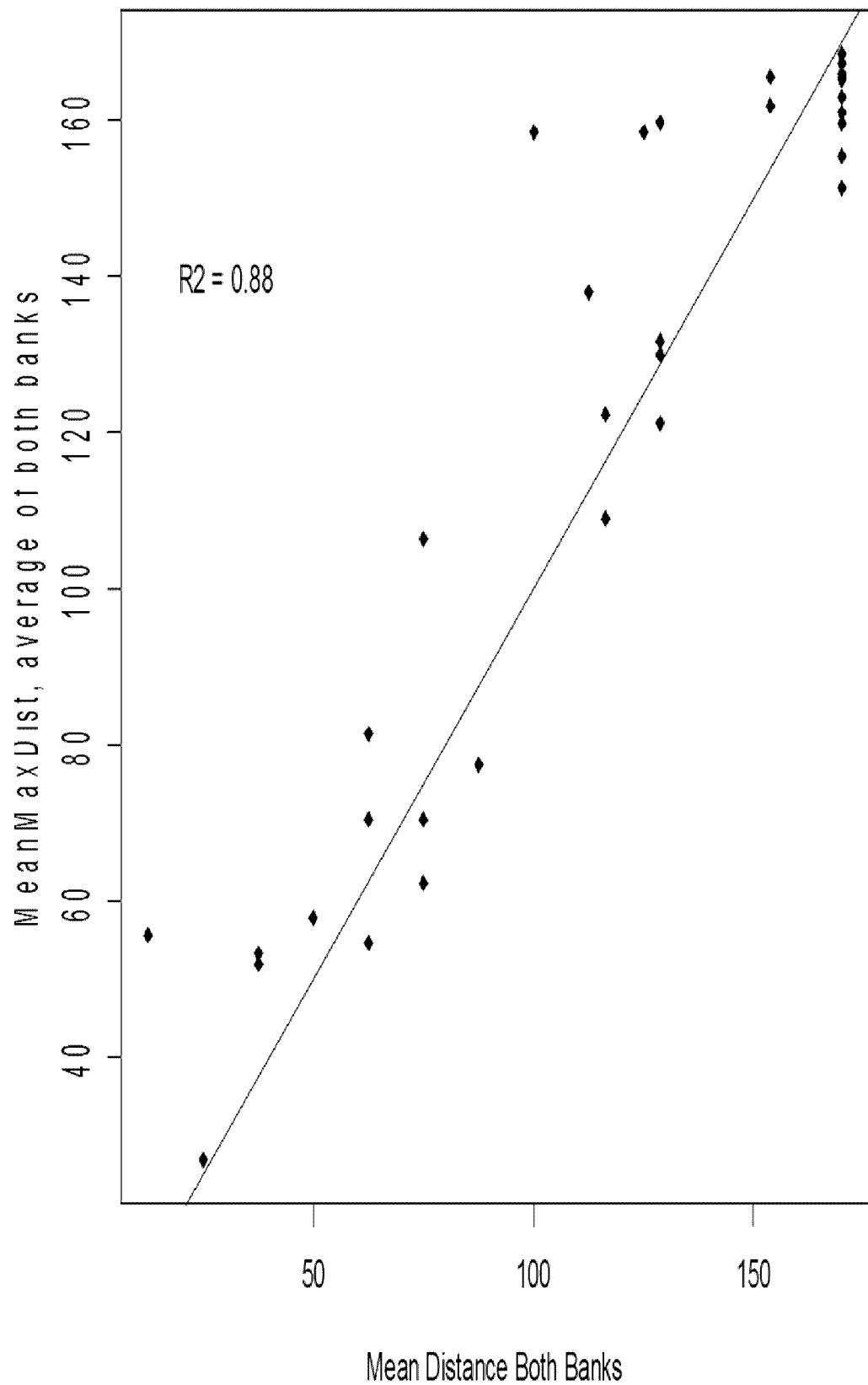
Mean?

MeanMaxDist

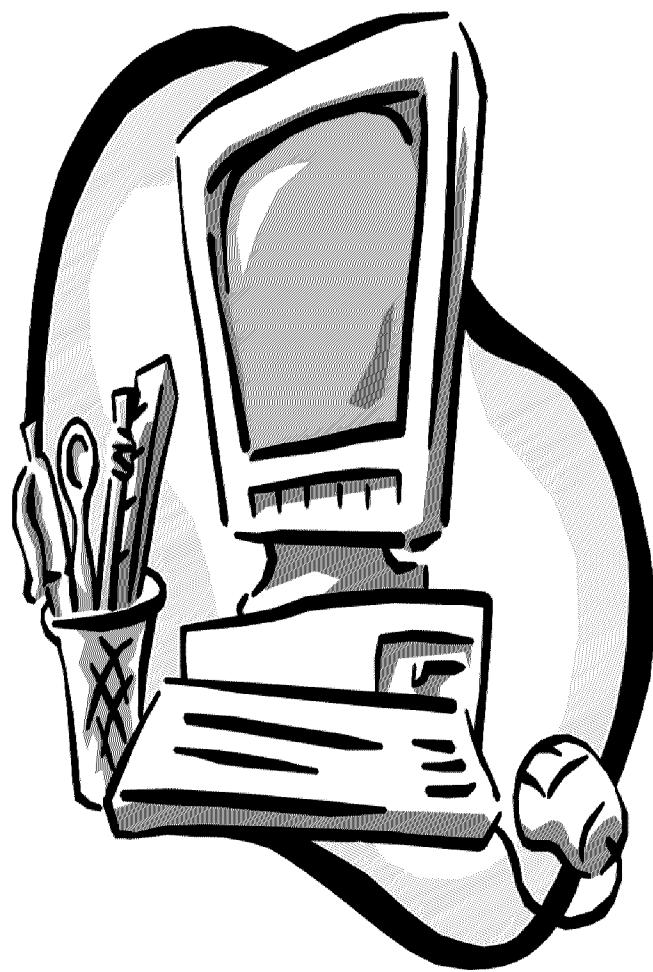
Max?

MaxMaxDist

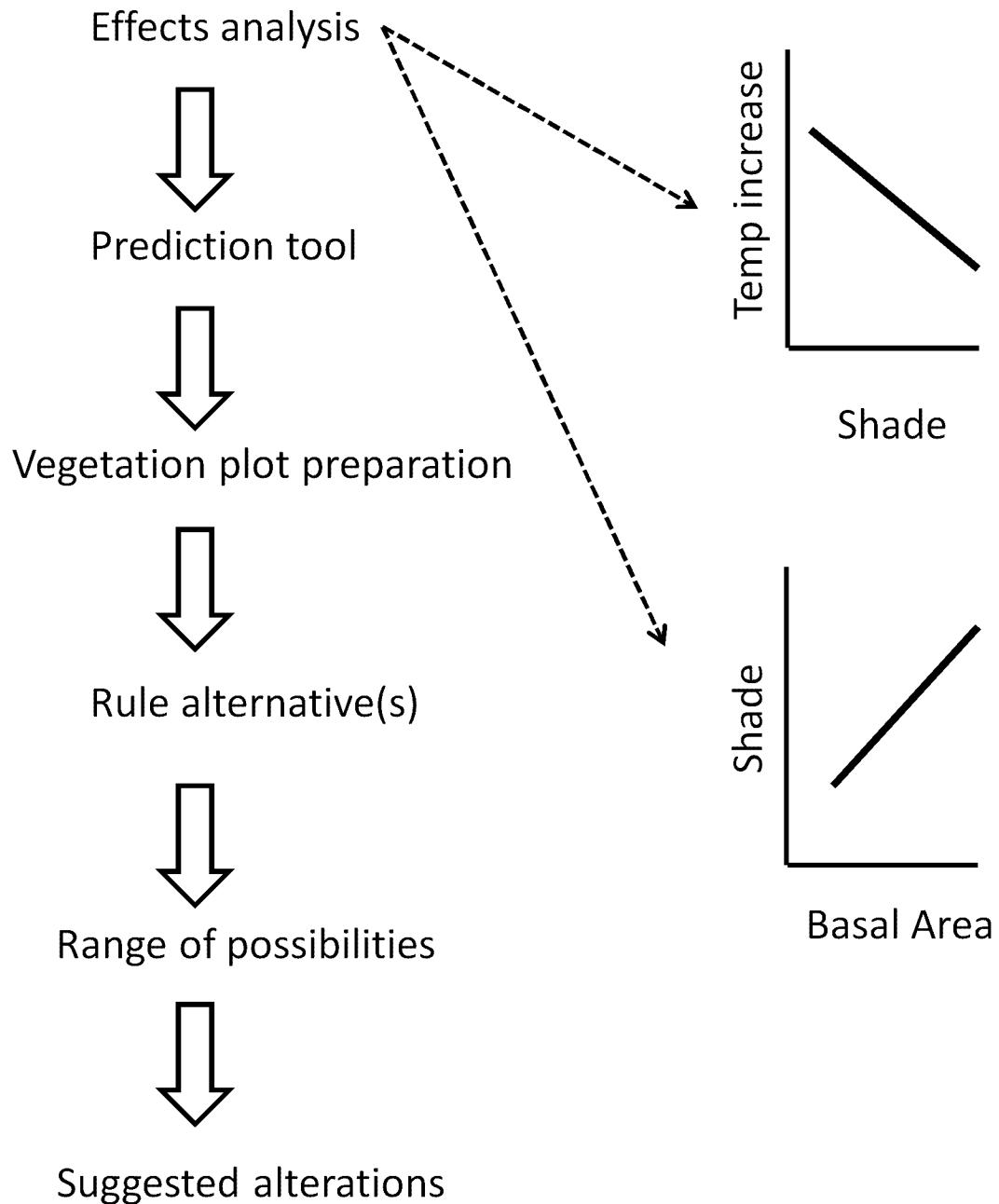
Comparison of MeanMaxDist (empirical) & MeanDistBoth (visual)



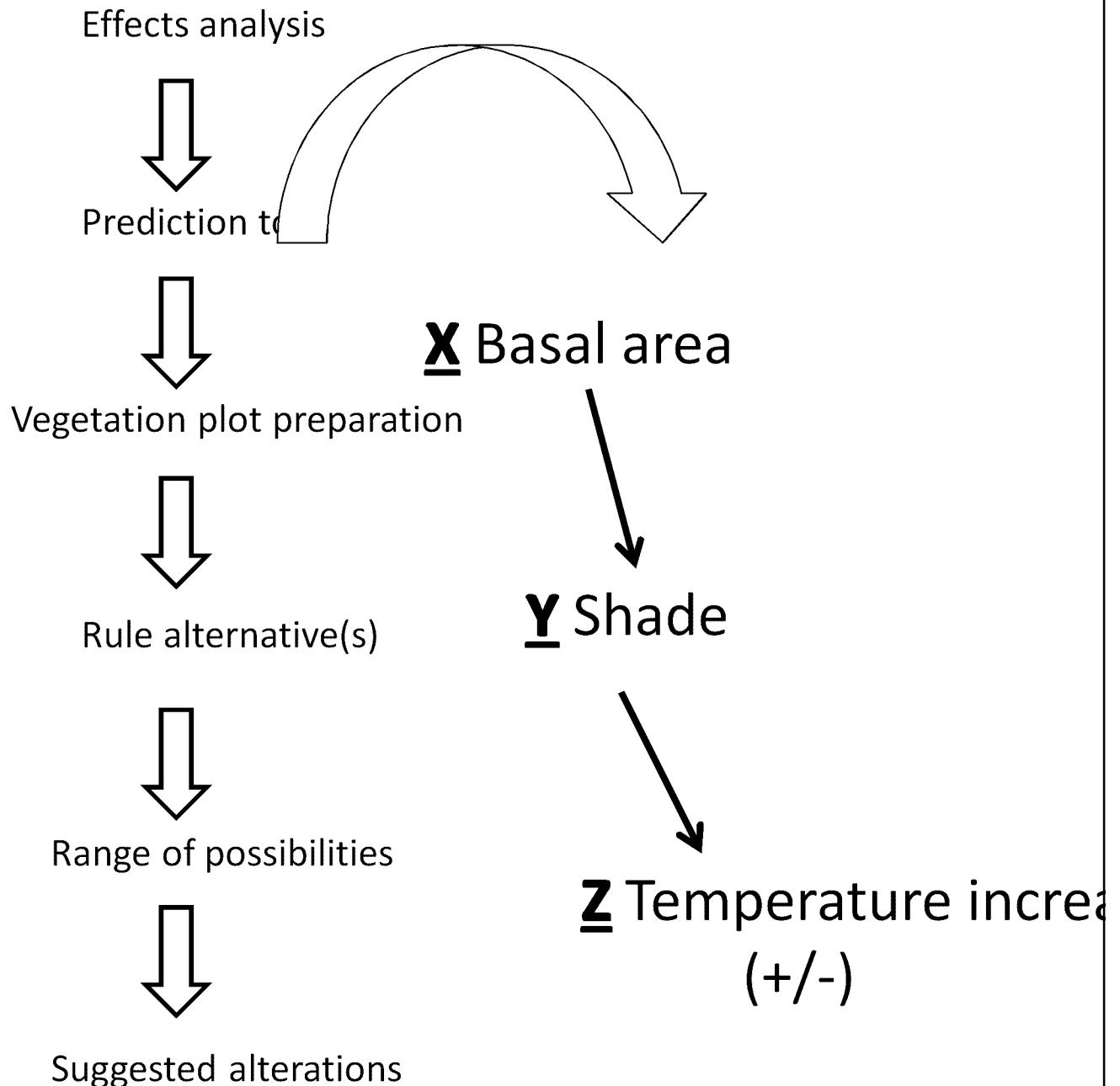
On to the Analysis...



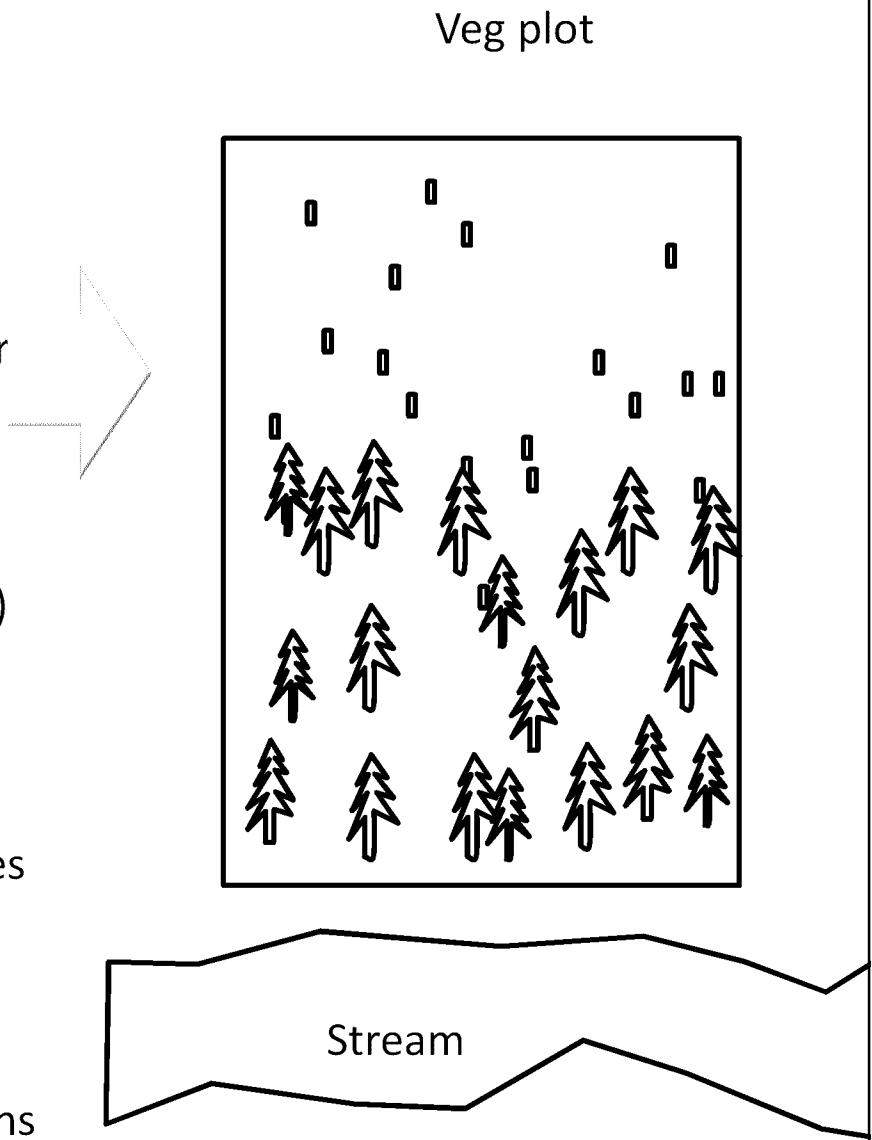
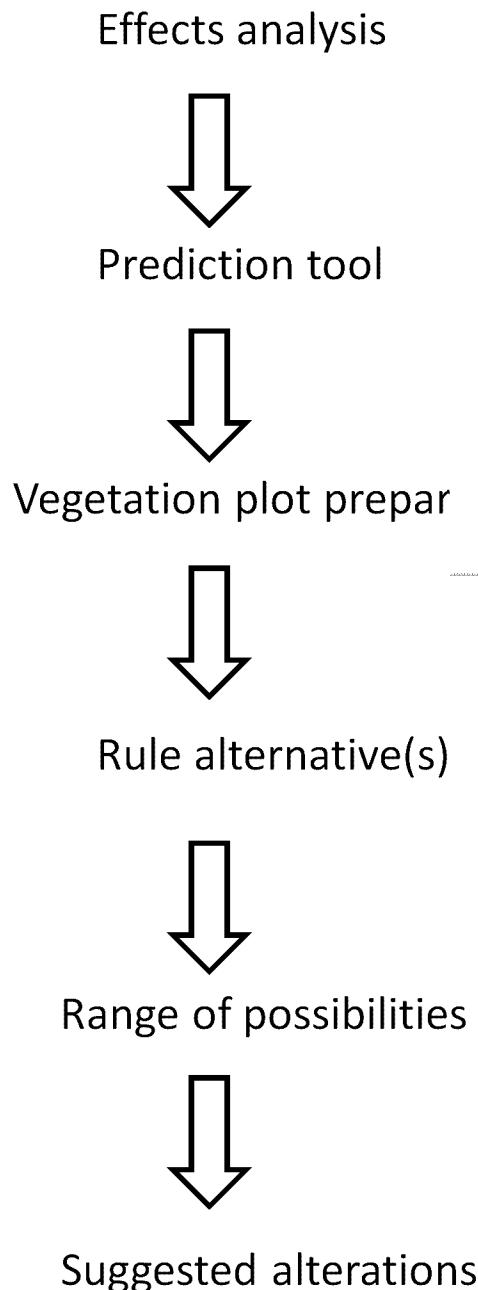
Analysis path concept



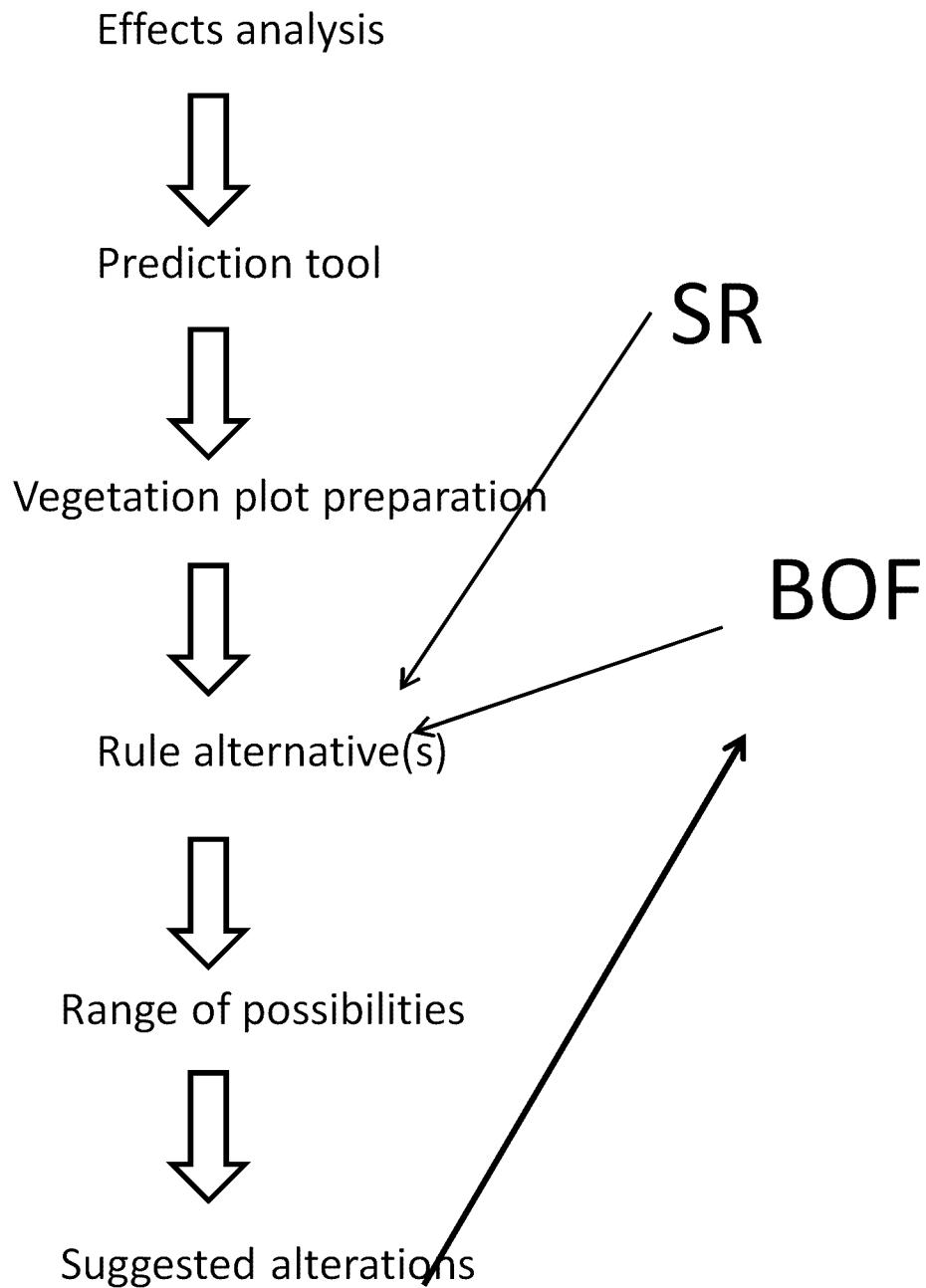
Analysis path concept



Analysis path concept

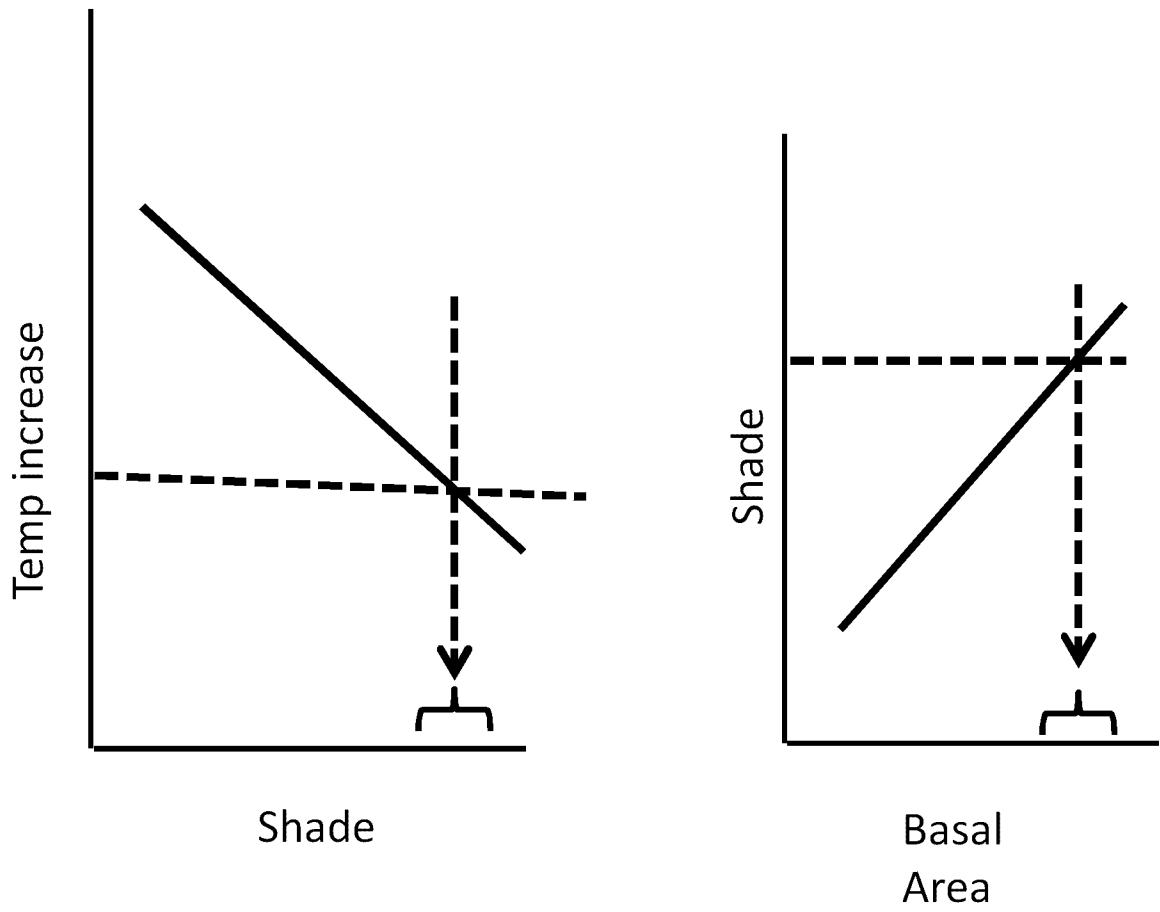


Analysis path concept



Prediction Tool

Temperature ← → Shade ← → Basal Area



Linking analyses

How can we effectively “tie” analyses together?

Thomas Bayes



Bayesian Analysis

- Bayesian & Frequentist
 - Frequentist: Data are random (random draws)
 - » Variables = fixed
 - Bayesian: Variables are random
 - » Data = fixed
- Key point: Models are the same.
 - Probabilities = different

Bayesian Analysis

- Why?? What does this give us?
 - Be able to say “80% chance that temperature increase will be less than 0.2 °C”
 - Single model, more information
 - Integrates many data sources easily, defensibly
 - Missing data estimated
 - Many assumptions, but true of MLE models too
 - Restrictions not as limiting

Making the jump

- Using same/similar models as before
 - Shade = weighted regression, Temp = mixed effects
- Coolness:
 - Two sites = missing pre-harvest temperature data, so analysis imputes values
 - With a Bayesian analysis, easy to estimate **whatever**
- Get ready for equations

Stream Temperature Change

- Temperature: for year i , measuring temperature change in j site...

Mixed Effects

$$\Delta T_{3-2ij} = \alpha_0 + \alpha_j + (\beta_1 \Delta T Control_{2-1} + \beta_i \Delta T Control_{2-1j}) \\ + \beta_2 TreatmentReachLength + \beta_3 Shade \\ + \beta_4 GradientQuartile$$

The diagram illustrates the mixed effects model. A rectangular box labeled "Mixed Effects" has two arrows pointing down to the equation. One arrow points to the term α_j , which is circled in red. The other arrow points to the term $\beta_i \Delta T Control_{2-1j}$, which is enclosed in an oval.

Detour: shade model development



The ideal shade model

For RipStream, the ideal shade model...

- Explains shade results well
- Makes sense
- Includes all data out to 170'
- Includes a measure of harvest distance

Published model Forest Ecology & Mgt 2011

Logit of shade = Basal area post-harvest
+ tree height

Model does well (explains ~ 70% variation)

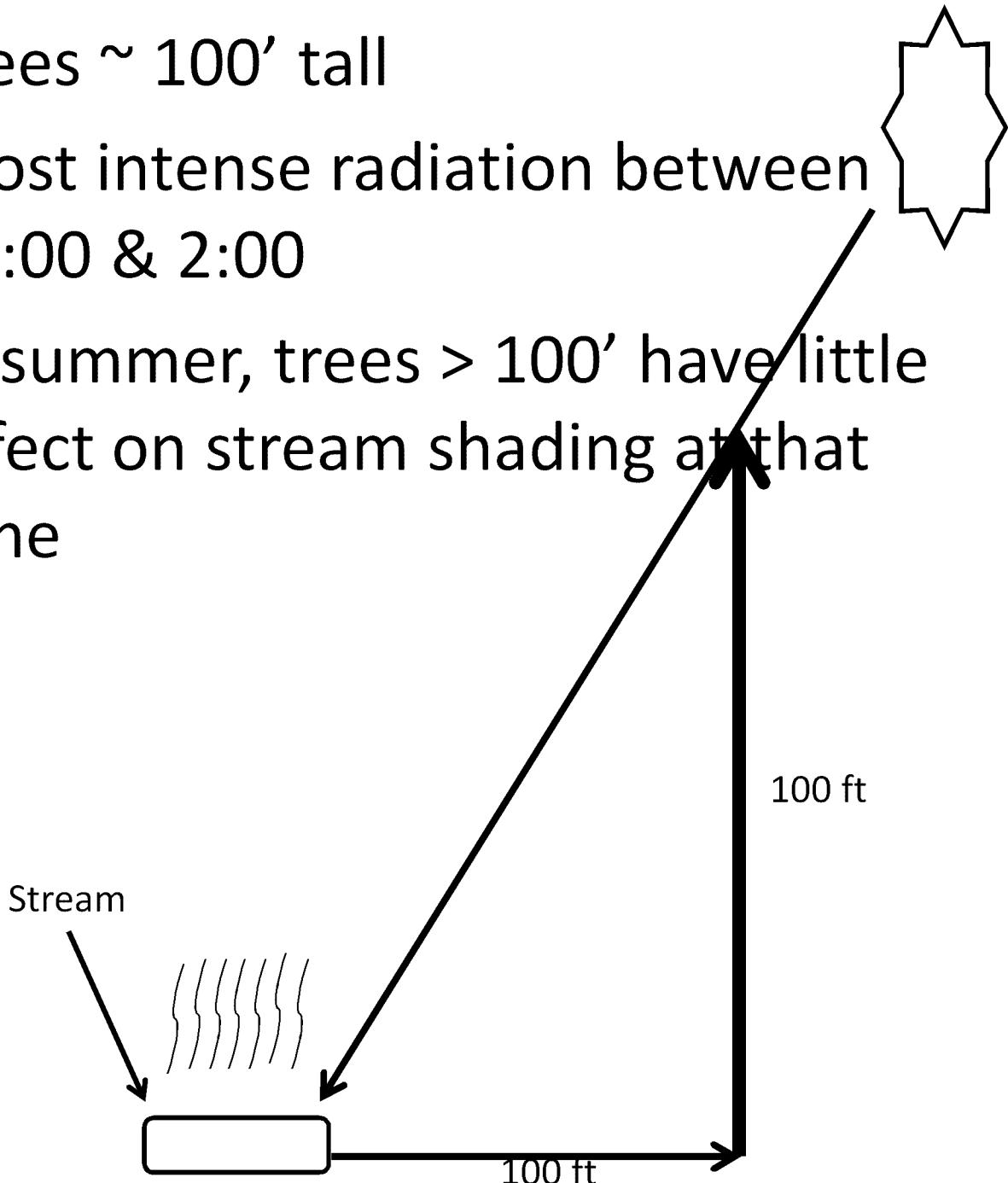
Examines forest out to 100'

Revised shade model: Shade 1

$$\begin{aligned} Shade_{Post} = & \alpha_{Shade} + \beta_{1Shade} BasalAreaPre + \beta_{2Shade} TreeHeight \\ & + \beta_{3Shade} BasalAreaPre * TreeHeight \\ & + \beta_{4Shade} BA_Reduction + \beta_{5Shade} PctHardwoodPre \end{aligned}$$

Why 100'?

- Trees ~ 100' tall
- Most intense radiation between 10:00 & 2:00
- In summer, trees > 100' have little effect on stream shading at that time

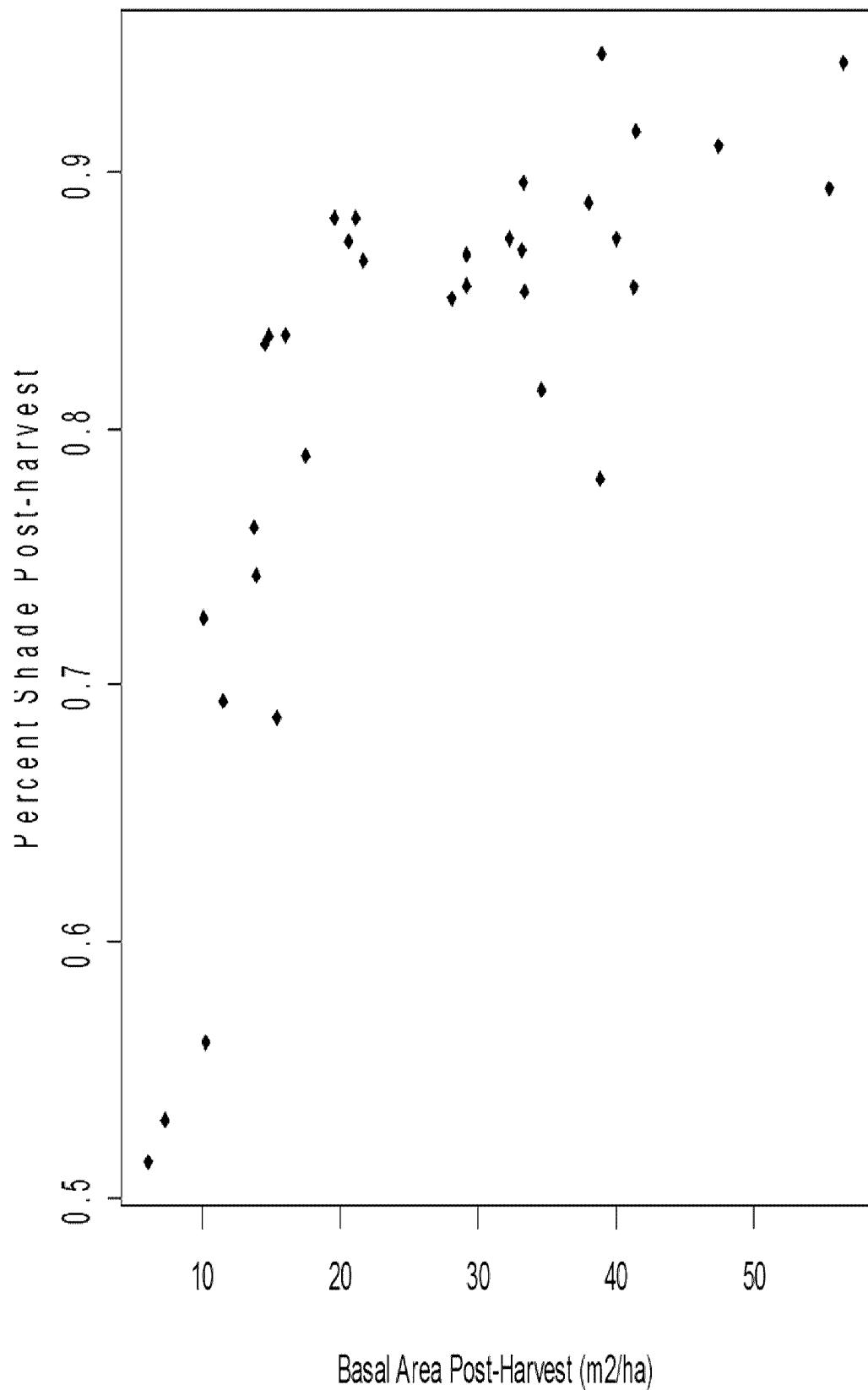


Out to 170'... how to include distance?

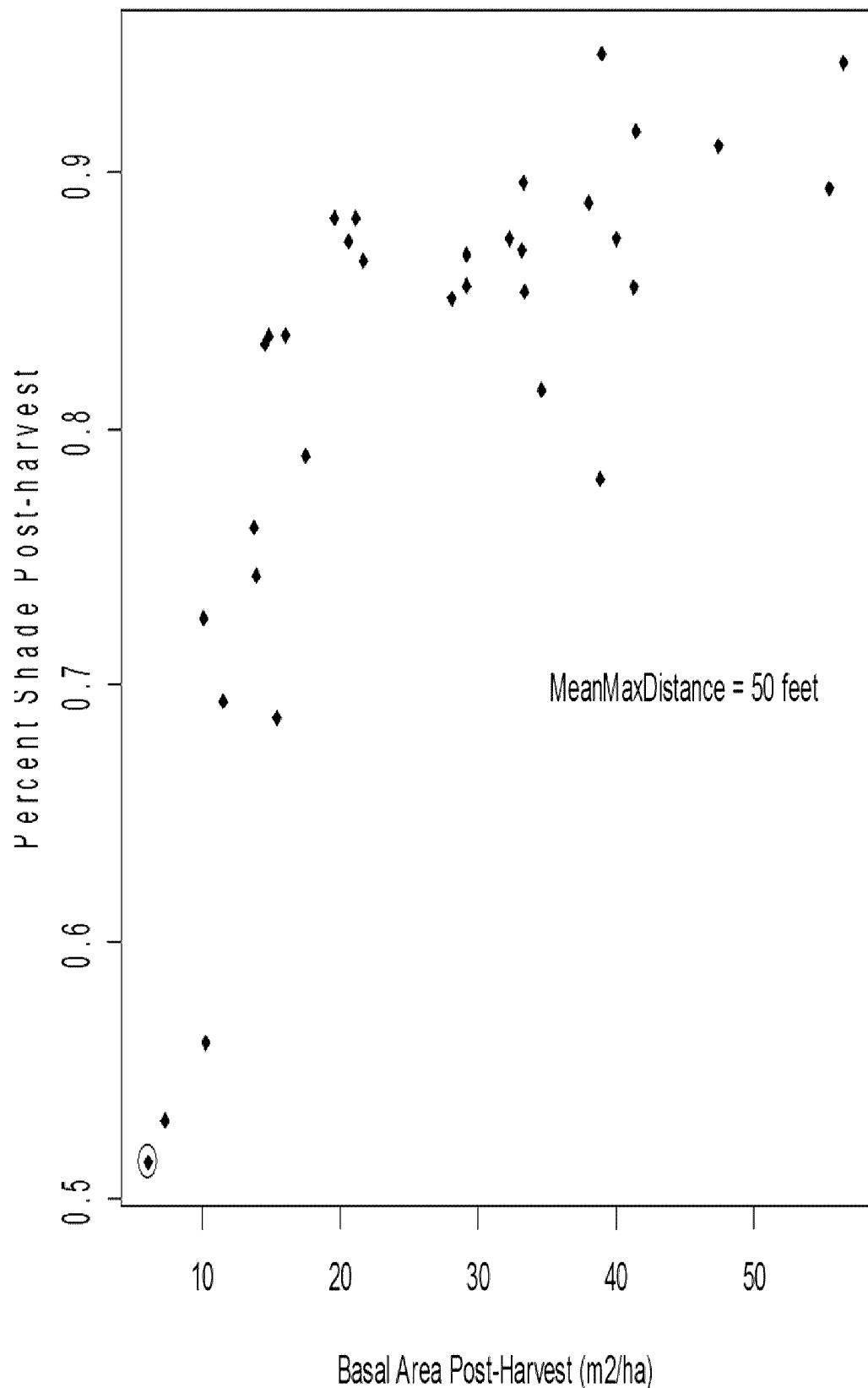
- We can include all trees out to 170'
- How do we include a measure of distance in the analysis? (What was the relationship between shade and distance?)
- How do we relate distance to basal area?

Using MeanMaxDist

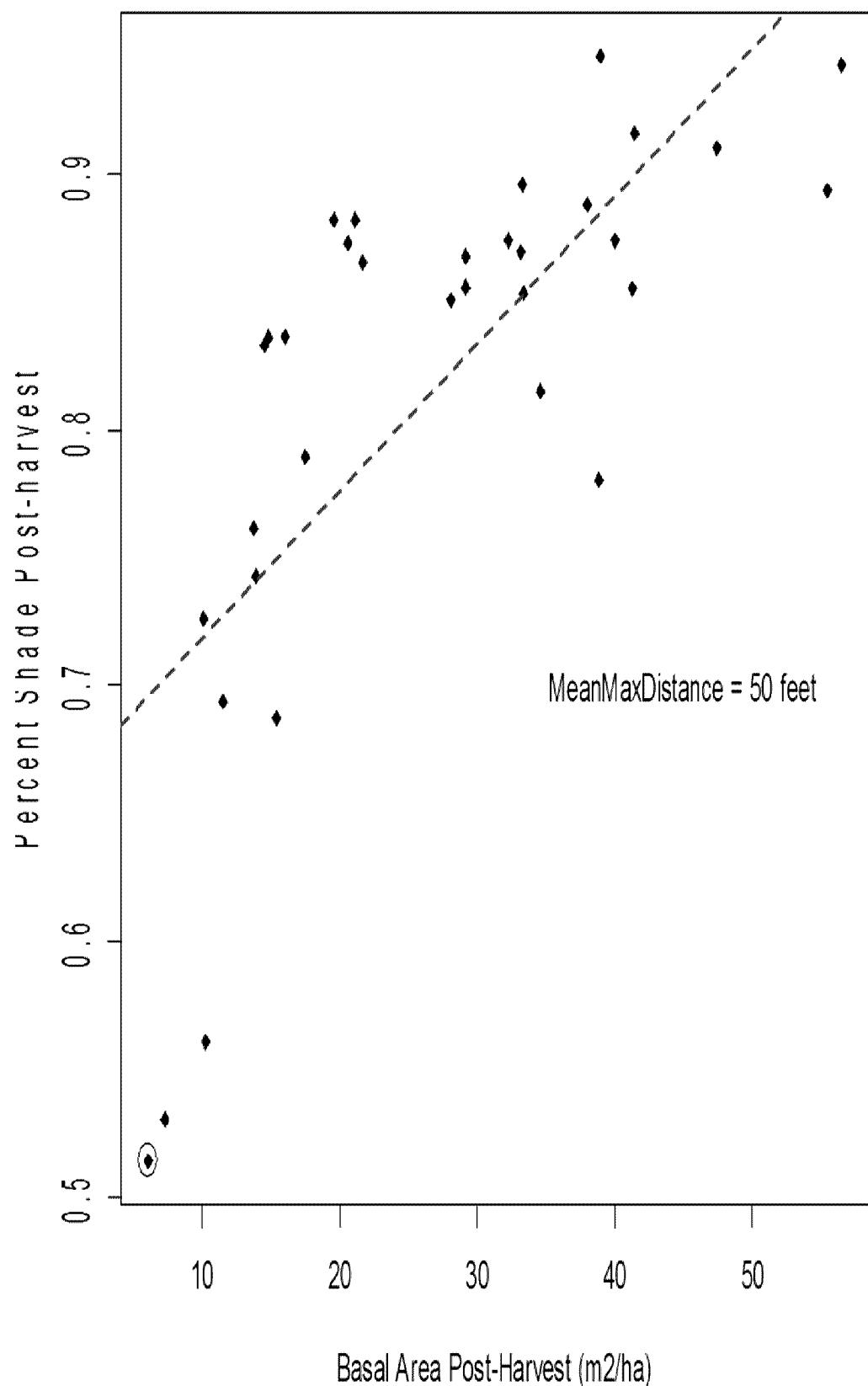
Shade vs. Basal Area



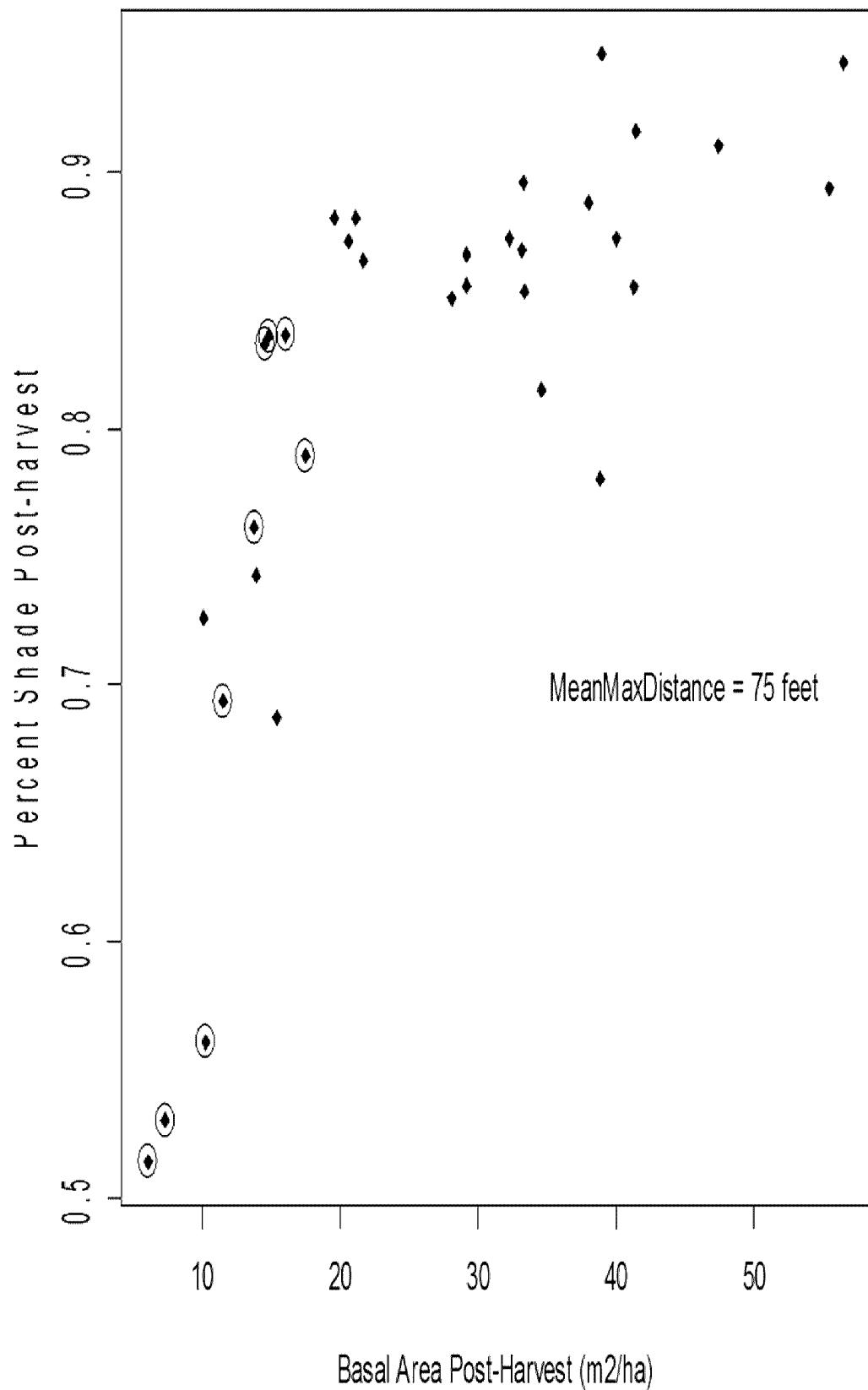
Shade vs. Basal Area



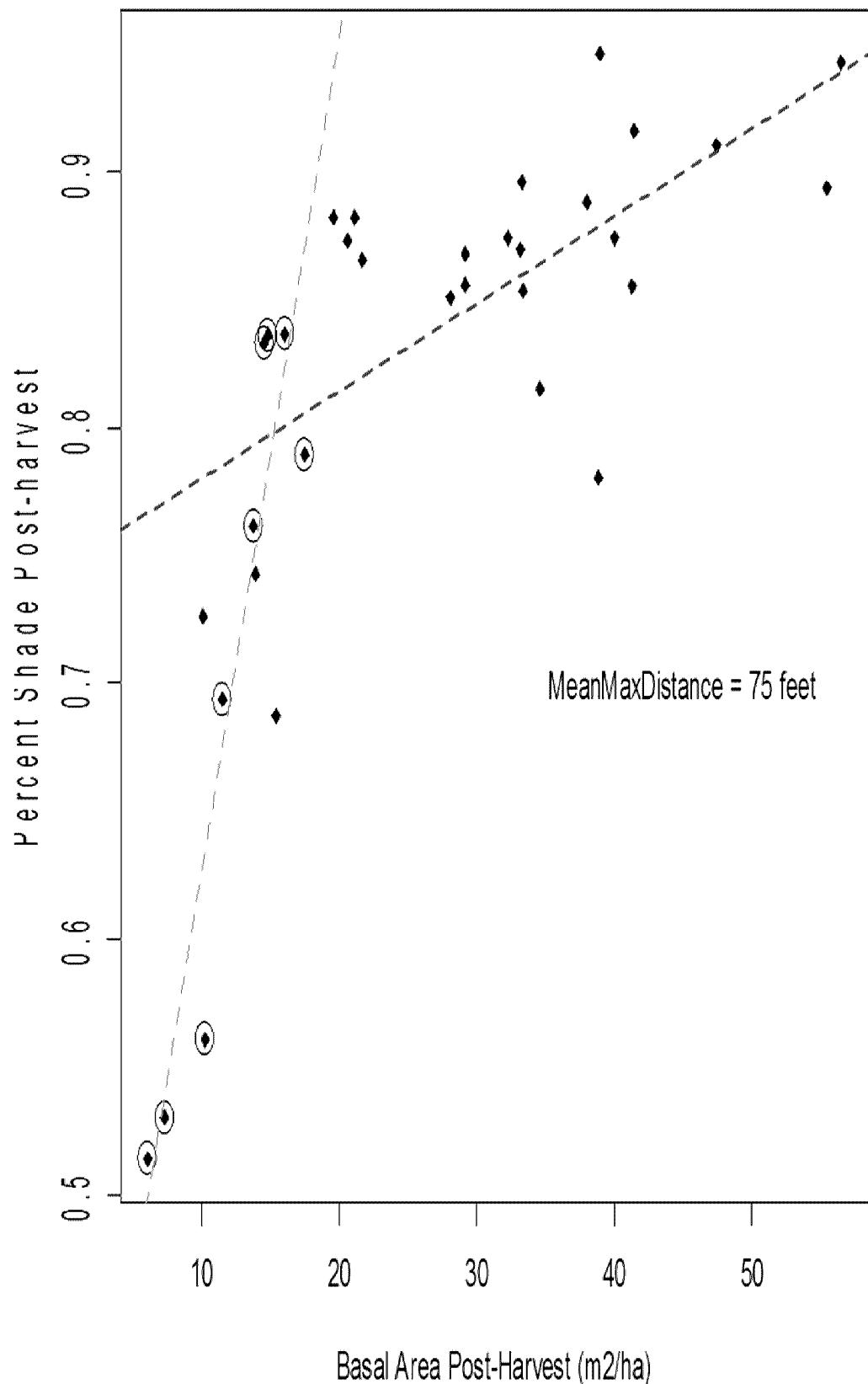
Shade vs. Basal Area



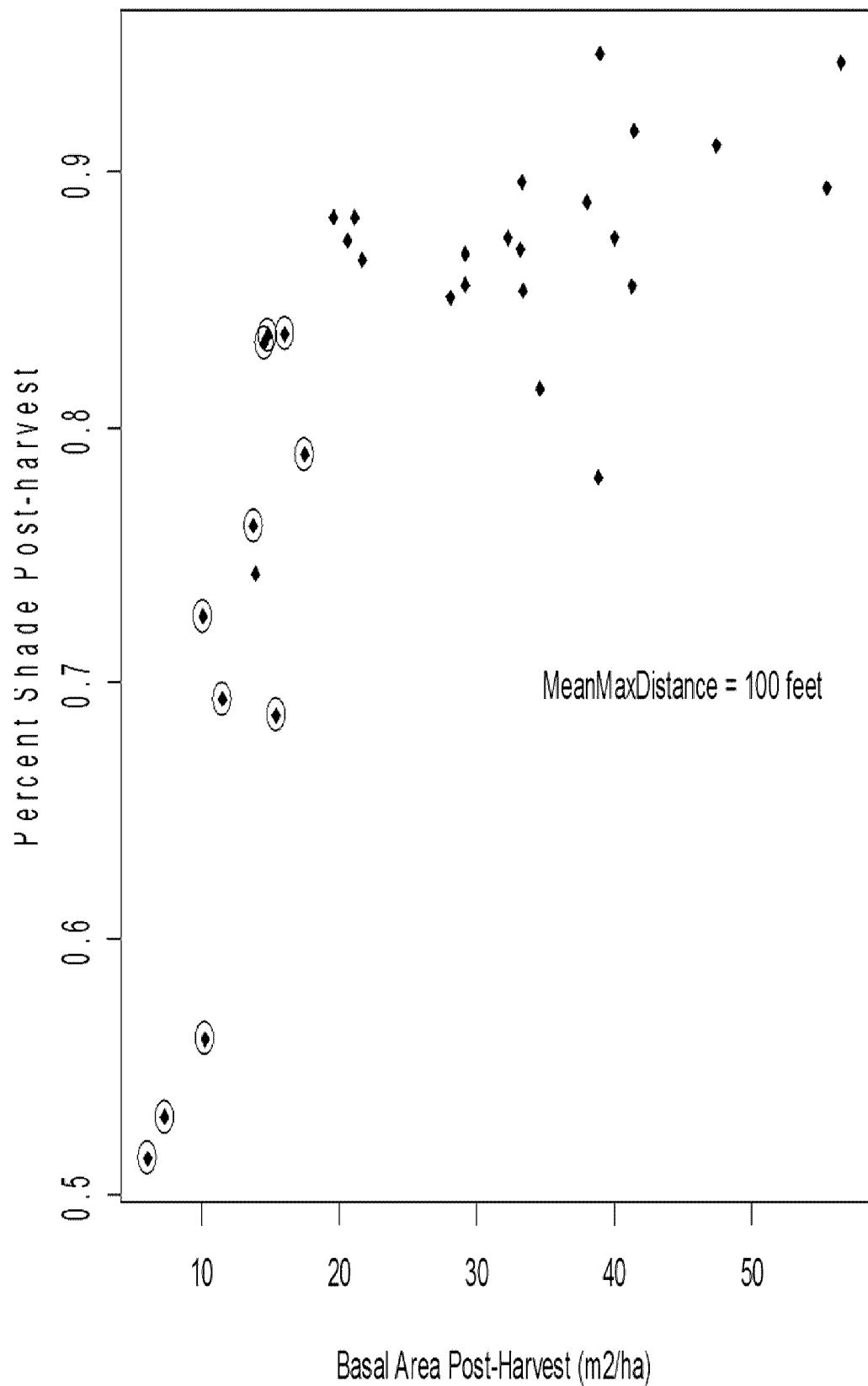
Shade vs. Basal Area



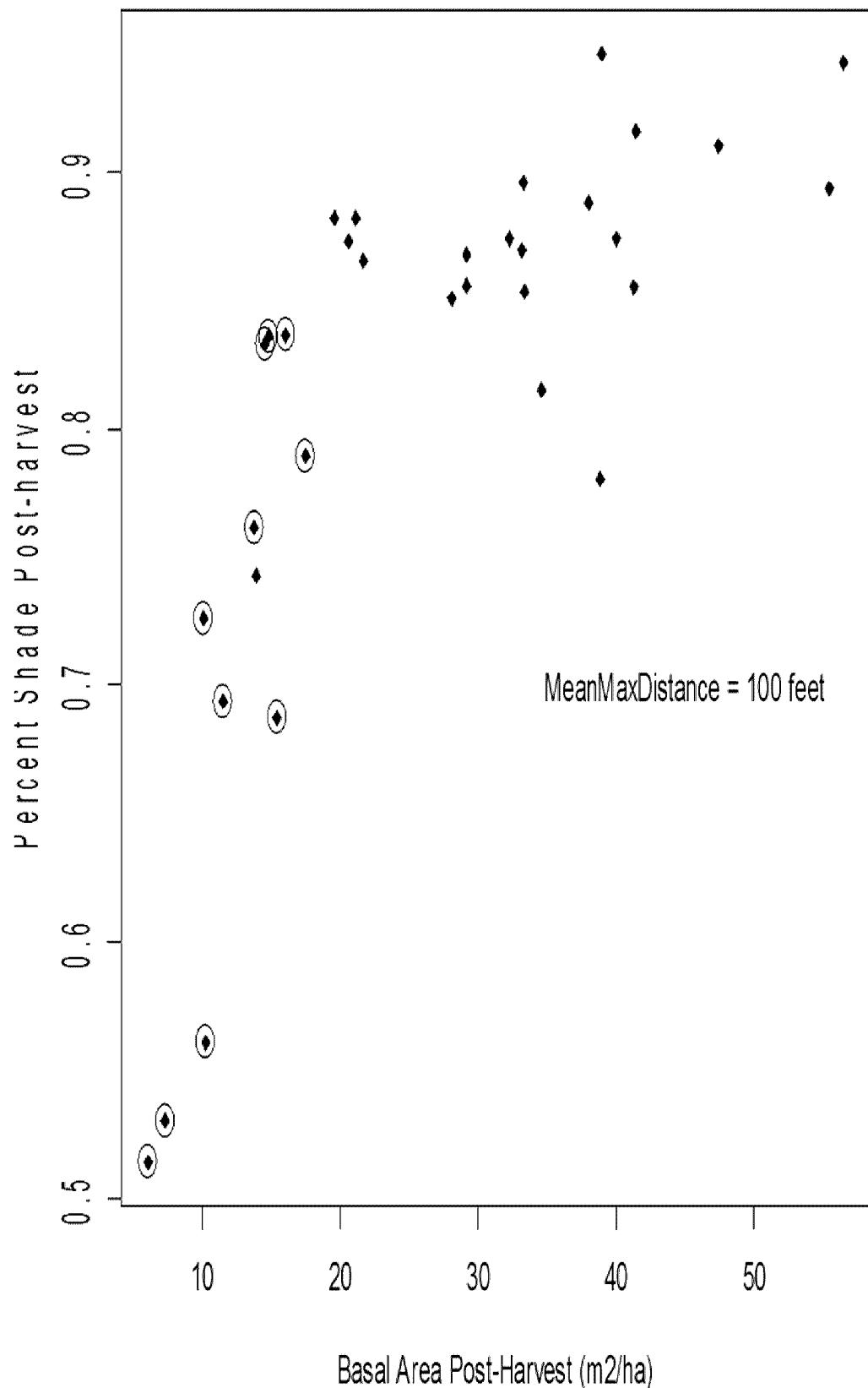
Shade vs. Basal Area



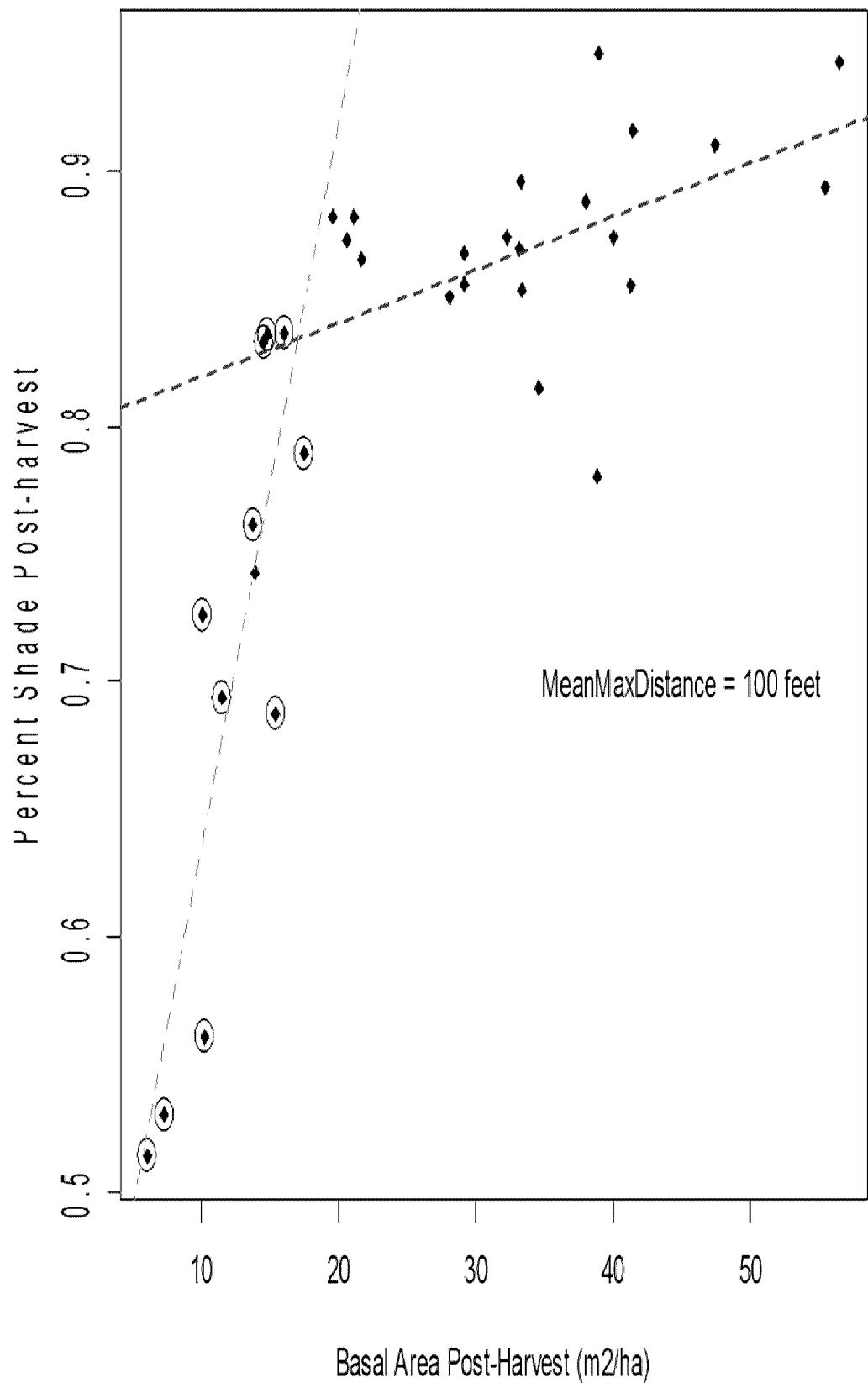
Shade vs. Basal Area



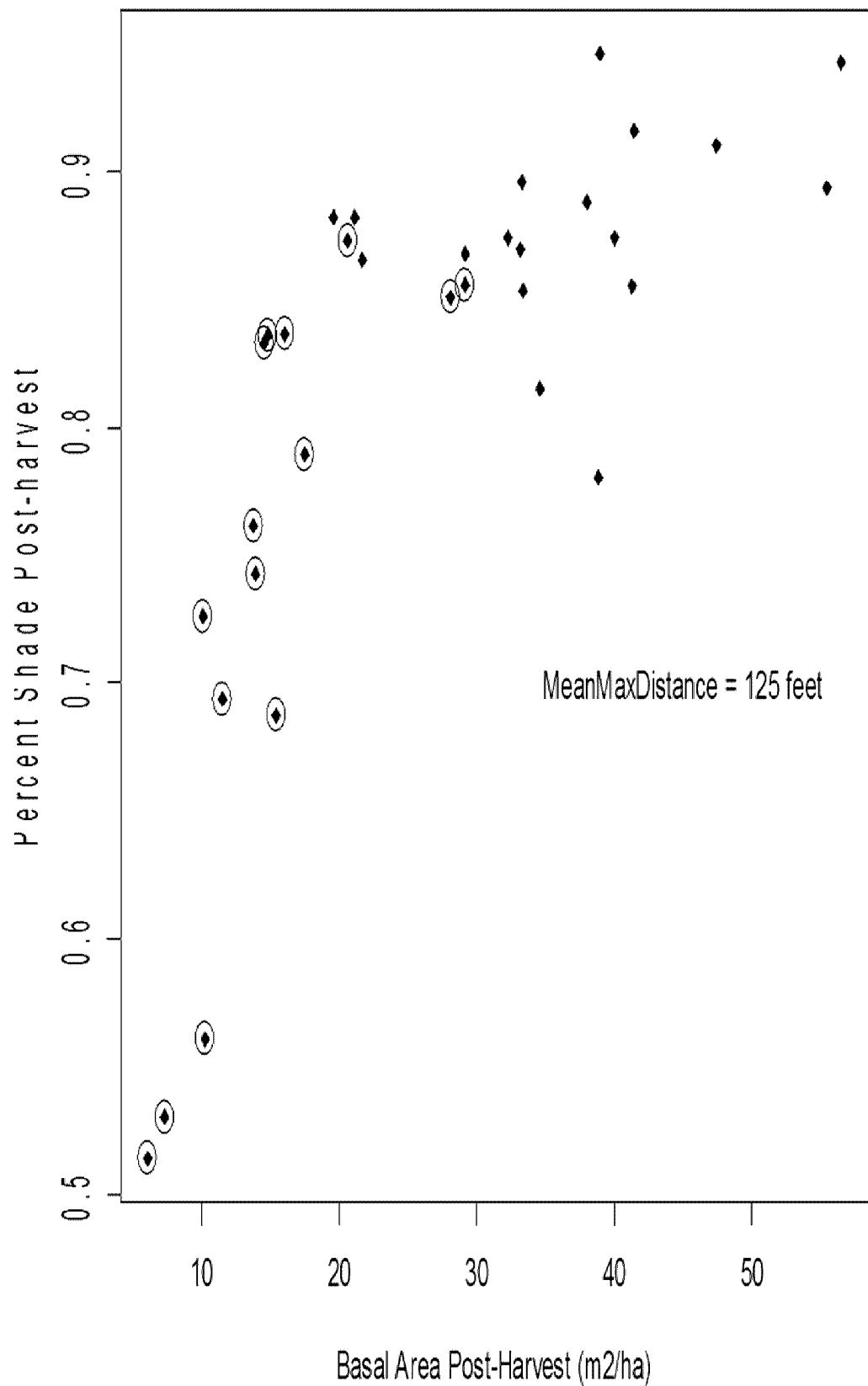
Shade vs. Basal Area



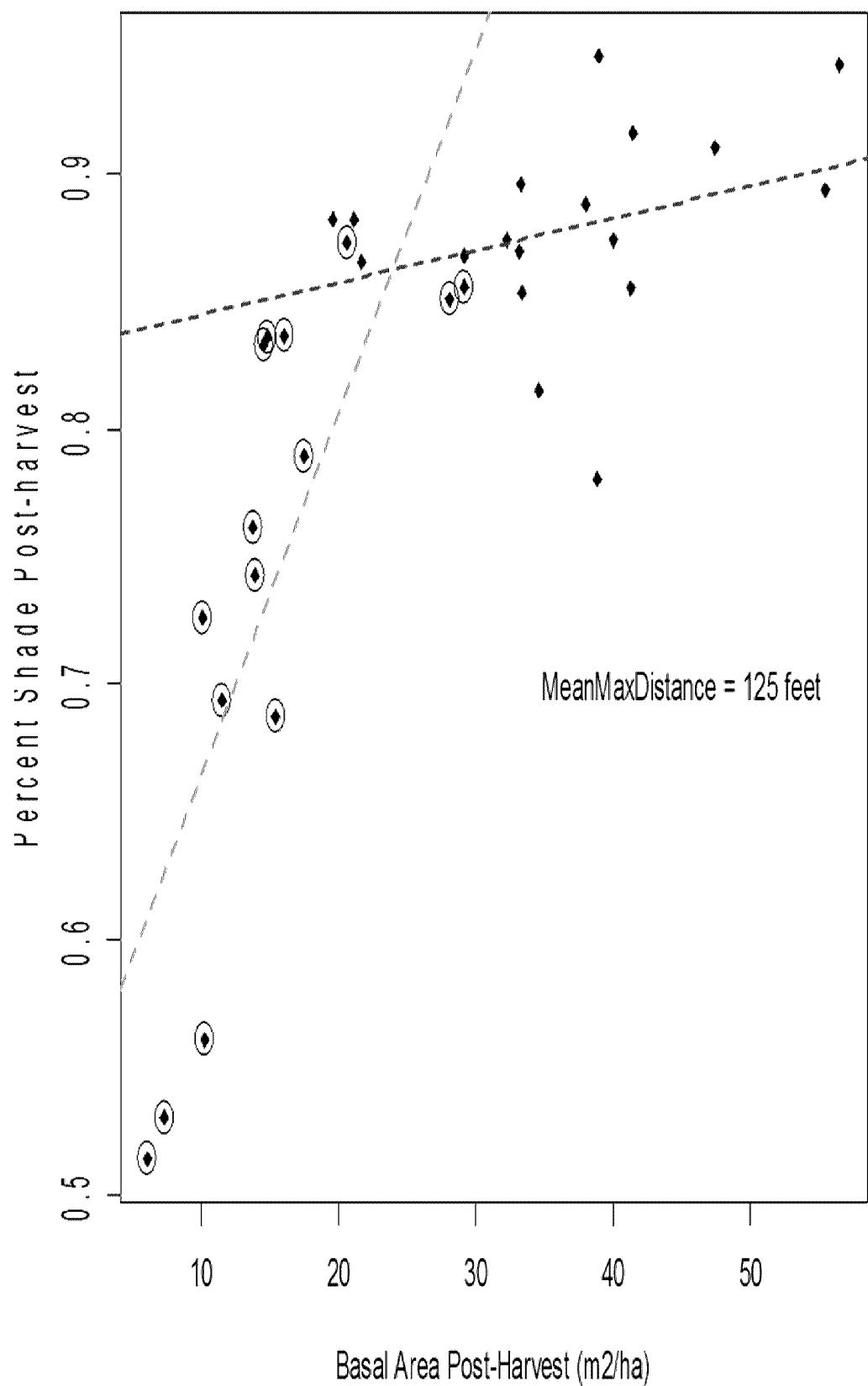
Shade vs. Basal Area



Shade vs. Basal Area



Shade vs. Basal Area

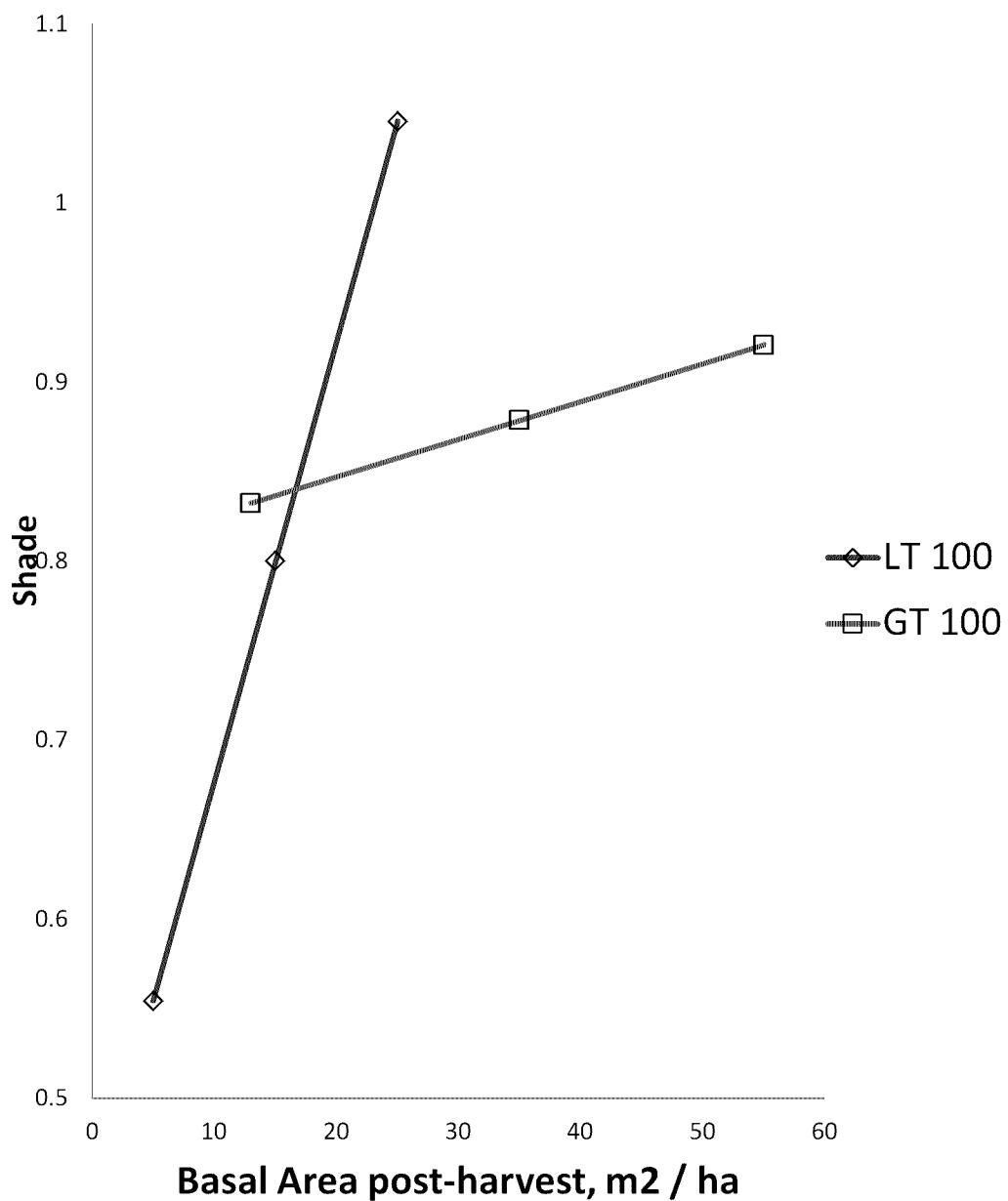


Shade v.2.0

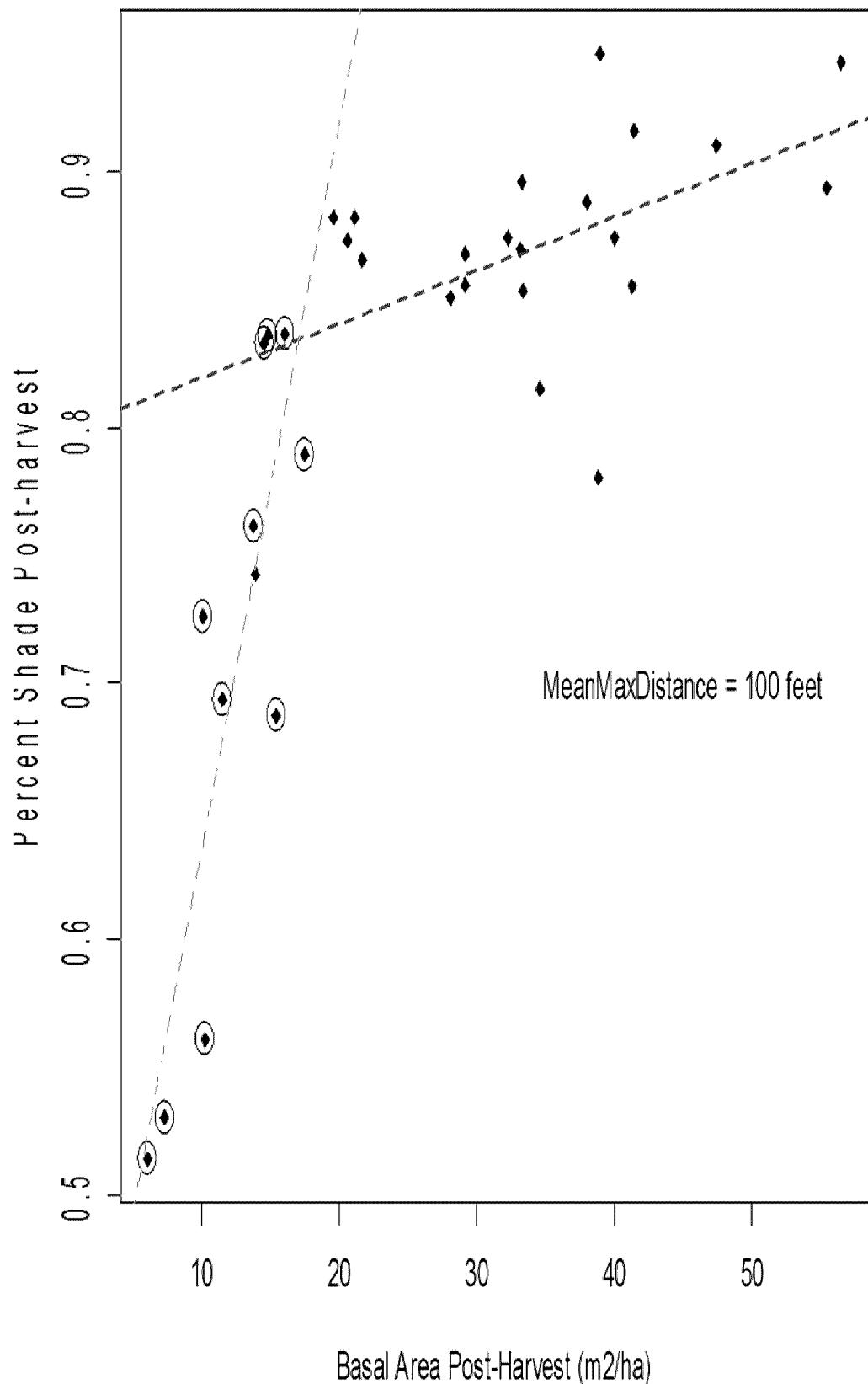
- Pre-harvest: Shade = raw shade data (not modeled)
- Post-harvest:

$$\begin{aligned} Shade_{Post} = & \alpha_{Shade} + \beta_{1Shade} LT100 + \beta_{2Shade} BasalAreaPost170 \\ & + \beta_{3Shade} LT100 * Basal AreaPost170 \\ & + \beta_{4Shade} TreeHeightPre170 \end{aligned}$$

**Shade retention by incursion distance,
</>100', mean veg plot extent**



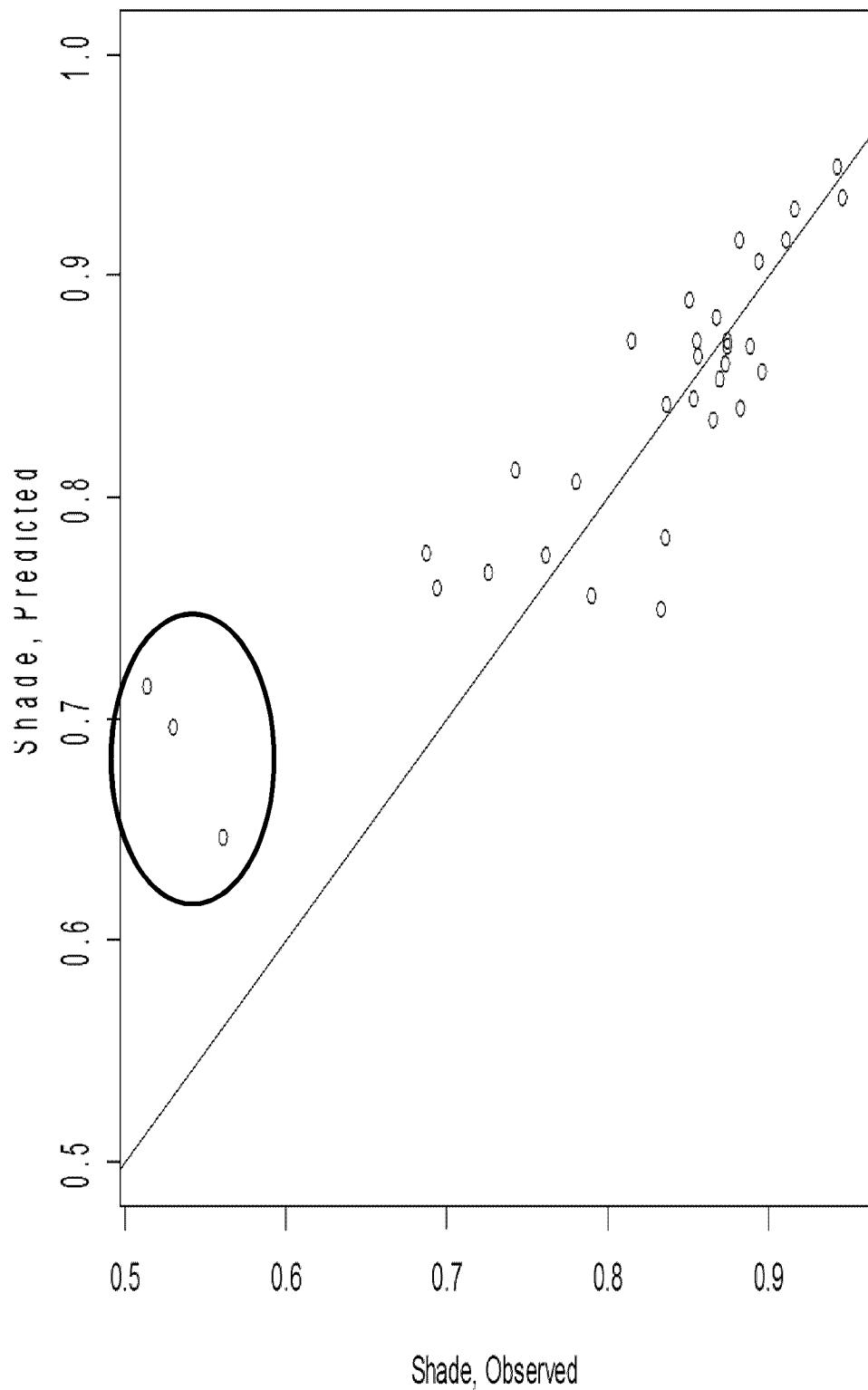
Shade vs. Basal Area



Shade decisions

- Reason to limit BA examined to <100'
- Didn't like Shade 1 (fit, too many variables, hard to explain)
- Logit of shade?

Shade 1: Observed data vs. Predicted



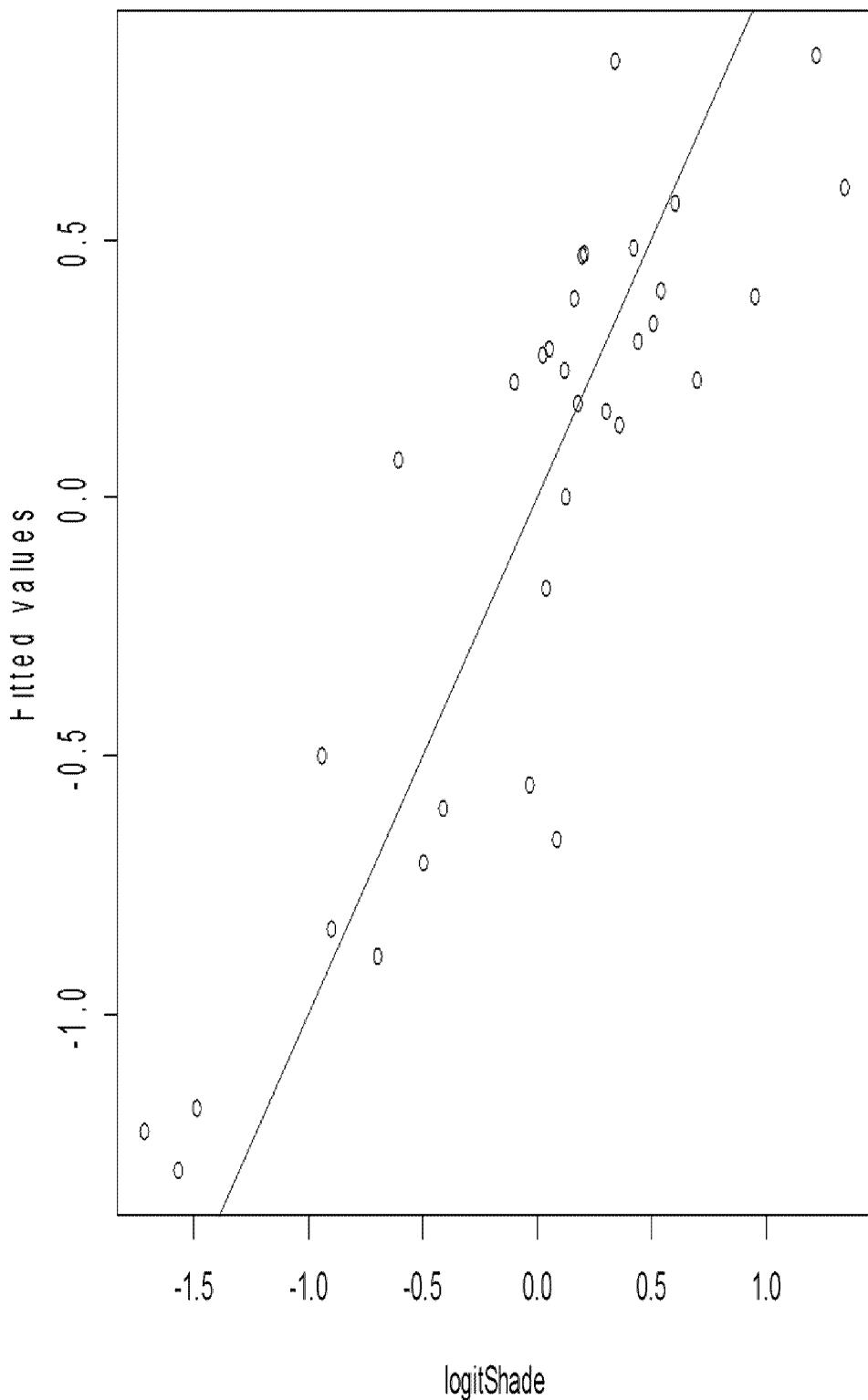
Shade 4(?)

- Within 100' of stream
- Logit shade depends on
 - % difference in basal area
 - Percent hardwood (preharvest)
 - Tree height (like original model)

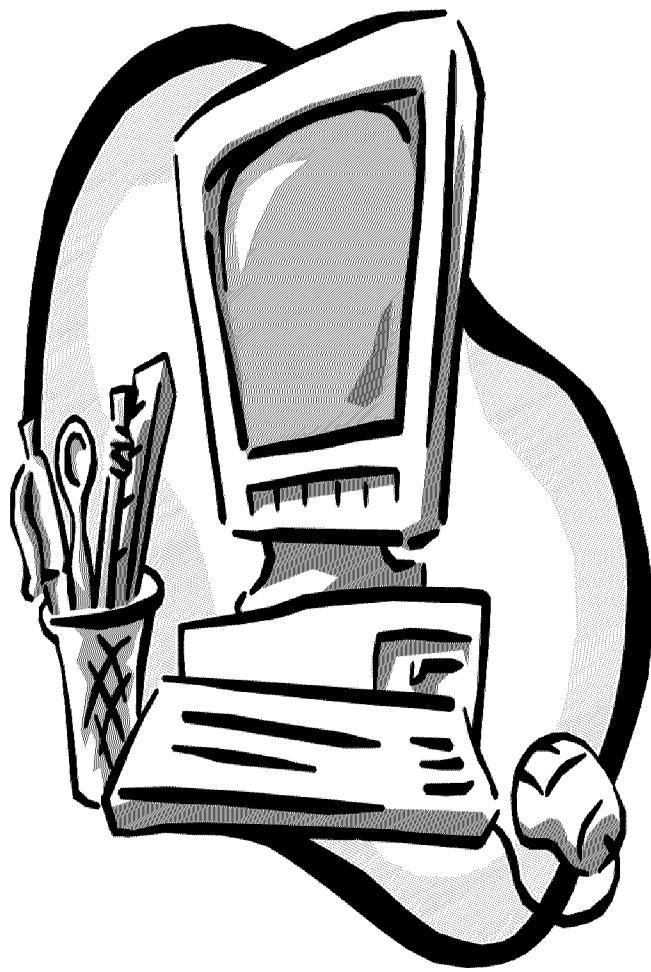
[4] ~~Logit Shade_{Post}78~~

$$\begin{aligned} &= \alpha_{\text{Shade}} + \beta_{1\text{Shade}} \text{PctDifferenceBA}_{100} + \beta_{2\text{Shade}} \text{PctHWD}_{\text{Pre}100} \\ &\quad + \beta_{3\text{Shade}} \text{TreeHt}_{100} \end{aligned}$$

Pred vs. observed values for lm2.6, logit shade



Back to the Analysis...



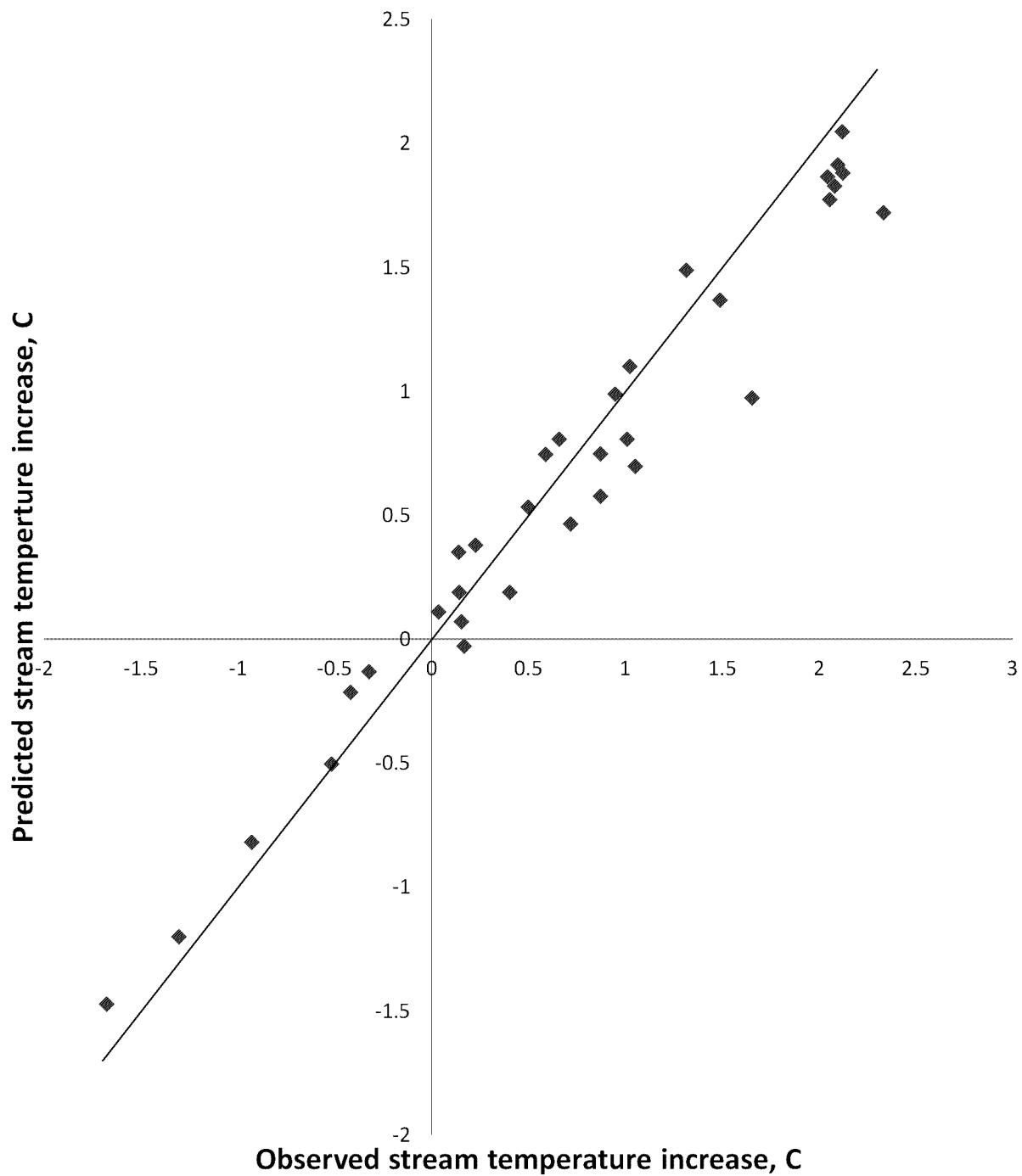
All estimated at once, Shade 4

Logit $Shade_{Post}$

$$= \alpha_{Shade} + \beta_{1Shade} PctDifferenceBA_{100} + \beta_{2Shade} PctHWD_{Pre100} \\ + \beta_{3Shade} TreeHt_{100})$$

$$\Delta T_{3-2ij} = \alpha_0 + \alpha_j + (\beta_1 \Delta T Control_{2-1} + \beta_i \Delta T Control_{2-1j}) \\ + \beta_2 TreatmentReachLength + \beta_3 Shade_{Post} \\ + \beta_4 GradientQuartile$$

Observed vs. Predicted Change in Stream Temperature



Prediction

$$\begin{aligned}\hat{\Delta T}_{3-2ij} = & \alpha_0 + \alpha_j + (\beta_1 \Delta T Control_{2-1} \\ & + \beta_i \Delta T Control_{2-1j}) \\ & + \beta_2 TreatmentReachLength \\ & + \beta_3 (\text{inverse logit of: } \alpha_{\text{shade}} \\ & + \beta_{1\text{shade}} PctDifferenceBA \\ & + \beta_{2\text{shade}} PctHwd_{100} \\ & + \beta_{3\text{shade}} TreeHeightPre_{100})\end{aligned}$$

For first year post-harvest,
Gradient Quartile

BA_Reduction =

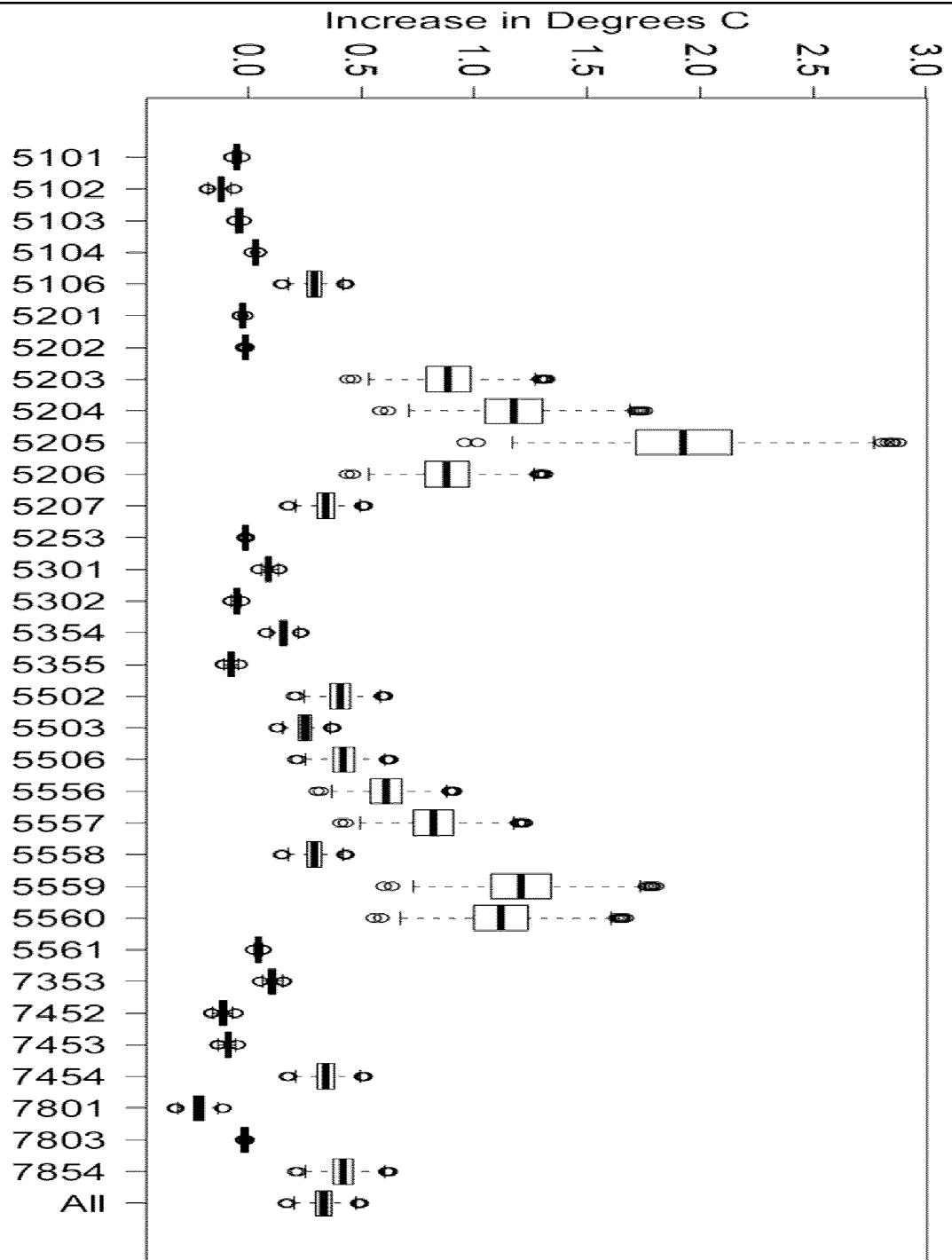
- 1) Simulated change
- 2) Zero change

→ Subtract these values. Get estimates.

As Harvested – Predicted (Shade 2)

State Mean = 0.001
= 0.57

Private



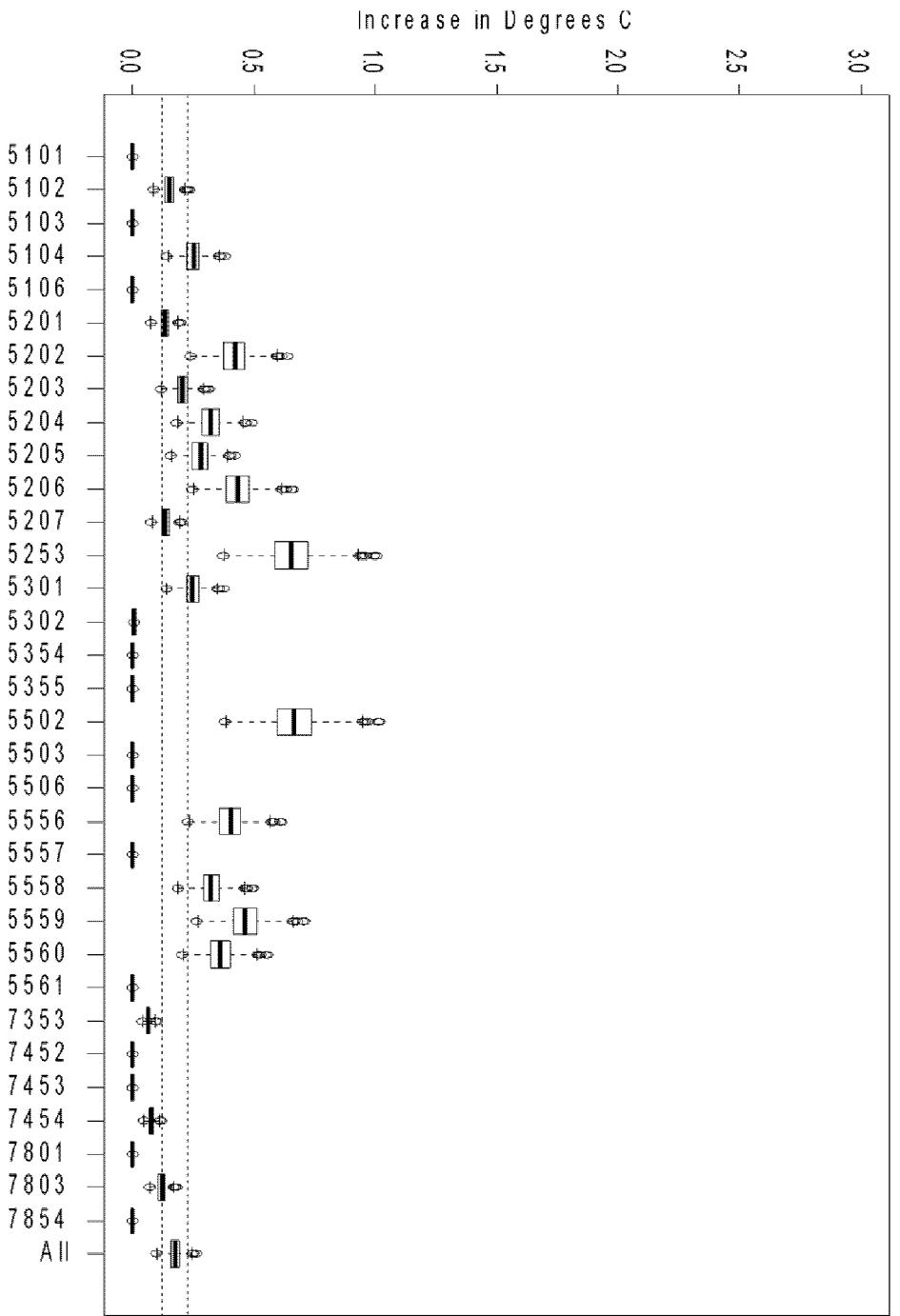
Harvest simulation

- Simulate harvests by specifying:
 - hardwood and conifer BA retention
 - Distance of no-cut buffers
 - Retention by diameter class
 - Number of retention trees
 - SDI
 - Height (harder)
- Report resulting basal area, basal area reduction, harvest distance (LT100)
- Can report other metrics

State Forests – Simulated (Shade 2, < 100')

Quantiles: 50% = 0.17 75% = 0.19
95% = 0.21

State Forest Harvest, All Sites



Next Steps

- Statistician input (Friday)
- Finalize shade model selection
- Predictions for SF & Private
 - Incorporating slope distance correction for Private
- Sensitivity analysis
- Explore suite of possible prescriptions
- Write up methods